AN ANALYSIS OF SHORE FACILITIES FOR HANDLING BULK PETROLEUM FUELS AT NAVAL ADVANCED BASES

ROBERT EARL SPARKS

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By

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Bachelor of Science, Texas Technological College

1934

Submitted to the Graduate School of the University of Pittsburgh in partial fulfillment of the requirements for the degree of Master of Science

Pittsburgh, Pennsylvania

1953

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PREFACE

The author is indebted to several persons whose assistance made possible the writing of this thesis. The work was completed under the direction of Professor H. G. Botset, Head of the Petroleum Engineering Department, University of Pittsburgh and a full measure of appreciation is expressed for his suggestions and guidance. Sincere thanks are extended to Commander R. A. Hansen, CEC, USN, and Mr. Earle Carlise, Bureau of Yards and Docks, Navy Department, for their invaluable help in providing reference material. The splendid cooperation of the staff of the Science-Technology Library, University of Pittsburgh is appreciated.

The writer is further indebted to the Navy Postgraduate School, Monterey, California for instruction and guidance relating to the requisite course of study and preparation of the thesis.

I. INTRODUCTION

Petroleum is an outstanding source of fuel, lubricants, and international friction.[1] Some writers have gone so far as to say that modern wars are fought with and for oil. While there may be differences of opinion as to the importance of petroleum in relation to world politics, there can be no doubt that wars today are fought and won with oil. Modern warfare is mechanized warfare, and without petroleum machines of war are useless.

For the foreseeable future petroleum heads the lists of strategic materials. Planning for war must be global in scope, and not only must petroleum production be sufficient to sustain a global war, but facilities for handling petroleum fuels and other products must be suitable for support of the armed forces under any situation. Modern warfare, then, demands that fuels be delivered to the using units wherever they are, and in sufficient quantity and quality to permit these units to carry out their missions - this means adequate fuel supply for ships, submarines, planes, tanks, and vehicles.

Waste and contamination must be held to an absolute minimum in the handling of petroleum fuels. Reduction in losses due to waste not only conserves fuel but manpower as well. Contaminated fuel can be just as dangerous to military operations as contaminated food since it can immobilize these ships, planes, tanks, and vehicles in forward areas, thereby exposing troops to enemy fire.

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A review of the offensive naval operations during World War II discloses that most of these operations were undertaken for the purpose of seizing and establishing advanced bases from which further offensives could be mounted and supported. Although successful in seizing and using advanced bases, it was apparent that improved facilities, equipment and techniques were needed, particularly where the handling of petroleum fuels was concerned. Installations for handling fuels at advanced bases are, therefore, being studied by the Armed Forces with a view to improving these facilities wherever possible.

(4) Evaporation from gasoline storage is one which results in substantial losses of fuel and tends to throw the product off specification.

II. PURPOSE

In addition to efficiency, simplicity of construction and operation are highly desirable where advanced-base bulk-petroleum fuels handling facilities are concerned. Standardization of materials, methods and procedures tends to facilitate construction and promote efficient operations of wartime bases. To this end the Bureau of Yards and Docks has designed functional components for advanced base fuel facilities such as those shown in Figures 1 to 9 inclusive in the Appendix, and operational instructions are contained in Navy Department publications such as the Fuel Depot Handbook.[3]

Not all of the problems relating to advanced base fuel handling are technical; however, in the analysis to follow the problems considered have been in general limited to those encountered in the field which are basically of a technical nature. The purpose of this study is to cite defects and advance modifications and improvements for their correction. Briefly stated the major problems in this category are as follows:

(1) Losses of products incurred and man hours required incident to the handling of drummed fuels during the assault phase of amphibious operations.

(2) The need for more reliable sea loading lines inasmuch as failure of these lines may seriously hamper or preclude vital fueling operations of fleet units.

(3) Short useful life of steel pipelines and tanks due to corrosion.

(h) Evaporation from gasoline storage tanks which results in substantial losses of fuel and tends to throw the product off specification.

III. NAVAL ADVANCED BASES

Advanced base, the primary mission of which is to support wartime operations of the armed forces, is a general term designating a base located in or near forward areas outside the zone of the interior. Such bases are deployed after declaration of an emergency or upon mobilization in direct support of combatant units and are usually of temporary wartime construction.[3]

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A. Types of Advanced Bases

There were several general types of advanced bases in World War II, viz:

(1) Those established to hold threatened strategic areas such as Kodiak and Adak, Alaska.

(2) Those established as part of or to protect a line of supply and communication such as those in Brazil and Samoa.

(3) Those which served as bases for direct offensive operations such as Tinian.

(4) Those which served to mount or support further offensives such as the amphibious bases in England.

(5) Those which were a combination of several or all of these such as Guam.

(6) Those which were established because of an imagined threat and which turned out actually to be safe areas such as the motor-torpedo boat bases on the west coast of Central and South America.

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B. Types of Advanced Base Fuel Installations

World War II advanced base installations usually included facilities for receiving, storing, and distributing bulk petroleum fuels. No two fuel systems were exactly alike, yet they may be classified as one of two general types, viz., (1) permanent installations on prewar bases, and (2) temporary advanced base installations in forward areas.

Construction on permanent bases outside the continental limits such as Argentia, Newfoundland, Bermuda, Trinidad, Hawaiian Islands, Johnston Island and Midway was begun by contractors before or shortly after the Japanese attack at Pearl Harbor. In some cases the contractor's forces were relieved by Naval Construction Battalions (Seabees) who completed the construction work. On these bases the fuel installations are of the permanent type, i.e. underground concrete or steel storage tanks, welded steel pipelines, stationary pumping and dispensing units, and fuel piers or fuel docks.

In decided contrast to the permanent facilities were those in the second group, the temporary advanced base installations in forward areas, particularly in the Pacific Ocean areas west of the Hawaiian Islands. It is primarily this type of installation that will be discussed in the following pages.

For the most part, the construction of shore installations at naval advanced bases in the Pacific was accomplished by Naval Construction Battalions for the support of land, sea, and air forces in the war against Japan, and for the most part the bulk fuel installations consisted of bolted steel storage tanks, light weight, groove coupling pipelines, and portable pumping units. In general these materials and equipment were

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Many of the fuel systems at naval advanced bases were originally dependent on sea loading lines for receiving from and discharing to tankers. Usually these lines were the first part of the systems to fail. The most common failures were due to the submarine hose parting or the hose and marking buoy being carried away by wave action, or failure due to the rupture of the pipeline which occurred usually at the point where it lay over a coral reef. Wherever practicable submarine lines were replaced with fuel docks, piers, or jetties.

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C. Amphibious Operations

Before these shore facilities could be constructed in the Pacific Ocean areas it was, in most cases, necessary to first secure islands for bases by means of amphibious operations against the Japanese who held the islands - names like Guadalcanal, Tarawa, Kwajalein, Eniwetok, Pelileu, Guam, Saipan, and Tinian are synonymous with the term amphibious warfare. In these amphibious operations, and particularly during the assault phase, there existed a major problem with regard to the handling of fuels. Until sufficient area could be cleared of the enemy, and bulk fuel pipelines and storage could be erected, fuel was supplied in drums. In addition to being wasteful the method of handling drummed fuels from ship to shore required extensive equipment, labor, and time. It is, therefore, desirable to eliminate the handling of drummed fuel over the beaches as early in the assault phase as possible.

After a study of World War II operations, the United States Marine Corps outlined in general the required military characteristics of bulk fuel handling equipment for the assault phase, viz:

(1) Capable of delivering a minimum quantity of fuel per day per Marine division (not including aviation products).

(2) Capable of delivering fuel with no rehandling at the transfer line or across the beach.

(3) Capable of installation by unskilled personnel.

(4) Transportable

(5) Capable of handling motor gasoline and diesel fuel simultaneously.

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(5) Capable of handling motor gasoline and diesel fuel simultaneously.

(6) Embody maximum protection against the hazard of fire.

(7) Capable of repair and maintenance in the field.

The Research and Development Board is, therefore, devoting study to the interim period between the time the beach is secured and the time tank farms can be erected, with a view to reducing the period of dependence on drummed fuels. The work on design and testing of the interim system is being closely coordinated with the United States Marine Corps.

Several approaches to the problem of transferring bulk fuel from tanker to shore have been or are being considered. In general these considerations involve the use of existing craft or modifications thereof such as:

(1) Modified LST

(2) LCVP and DUKWS plying between tanker and shore

(3) Converted fleet submarine

For purposes of handling fuel on the beaches in the bulk, two collapsible storage tanks both of 1000 barrel capacity are under development:

(1) A pillow-shaped tank of pliable material 160' x 12' and weighing 2400 pounds which can be rolled for shipment in a package 13' x 4' x 4'.

(2) A dual wall tank erected by compressed air resulting in a cylindrical container 30 feet in diameter and 8'-6" high.

Light-weight collapsible hose has been developed which can be used with an interim fuel system in lieu of pipe. This hose can be distributed from trucks at about 15 miles an hour.

Portable pumping units for an interim system present no particular problem inasmuch as suitable units are available over a wide range of capacities.

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D. Fuels Handled at Advanced Bases

During World War II it was necessary to provide bulk handling facilities ashore for fuel oil, diesel oil, and gasoline (motor and aviation grades). To this list jet fuel must now be added.

1. Fuel Oil

The principal characteristics of fuel oil are given in Bureau of Ships specifications.[3] The most important properties from the standpoint of bulk plant operation are viscosity, specific gravity, stability, compatibility, water and sediment content (B.S. and W.), and inflammability.

The two Navy grades of fuel oil in general use are: (1) Grade I or Special with a maximum specified viscosity of 225 S.S.U. (0.48 Stoke) at 122° F. (50° C) and (2) Grade II with a maximum viscosity of 150 S.S.F. (3.19 Stokes). The Navy Special fuel oil which is used exclusively in steam driven combat ships is a relatively free flowing liquid which can be stored and transferred with little or no heating in mild climates. Grade II requires some heating, but can usually be transferred at 85° to 90° F.

Prior to about 1943 Navy specifications referred to the grades of fuel oil as A, B, and C. Bunker "C" became a colloquial term used both in and out of the Navy for a viscous oil of about 300 S.S.F. maximum viscosity. It was frequently very difficult to handle this grade, and as supplies on hand were exhausted burners were converted for use with either Navy Special or Grade II fuel oil.

The specification limits of API gravity for Navy fuel oils have no direct purpose other than to insure that water will settle from the oil, the settlement of water obviously being much slower in oil having

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The specification limits of API gravity for Navy fuel oils have no direct purpose other than to insure that water will settle from the oil, the settlement of water obviously being much slower in oil having almost the same density as the water than in lighter oils (higher API gravity). Navy Special usually runs about 4° API higher than Grade II, but either can vary over a 4° range. Cracked fuel oils normally have lower API gravities than straight run crude residuals of the same viscosity.

The stability of a fuel oil is that property of the oil which resists sludge formation and sedimentation. Up until about twenty-five years ago most fuel oils were the residuum from the simple distillation of crude oil, and were as stable as the crude from which they were derived. However, when cracked fuel oils first came into general use difficulties from instability developed. The most troublesome effect was the formation of adherent deposit in oil heaters. The cracked oil having had its molecular structure violently disturbed and re-arranged in the cracking process, continued to undergo slow chemical change which was accelerated by reheating. As a result of an intensive study of the stability of cracked fuel by the refiners and the Navy, a fuel oil of reasonable stability was produced under controlled refinery processes.

It was also soon evident that cracked oils were not always compatible, i.e. two oils from different sources and of different composition might be reasonably stable individually, but might react with each other when mixed, depositing sludge or becoming unstable and tending to build up deposits on heaters. Because of the possibility that different shipments of fuel oil may be incompatible, it is desirable to transfer and store the shipments in such a way as to avoid mixing. Under wartime conditions and at advanced bases, it may not always be possible to handle shipments separately; however, all effort practicable should be made to hold mixing to a minimum.

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Diesel fuel and boiler fuel oils are even more likely to be incompatible. Diesel oil may be a straight run gas oil of paraffinic properties quite different in nature from cracked fuel oil. Not over two per cent of diesel oil can be added to fuel oil without danger of throwing the fuel oil off specification. Contaminated diesel from ships' bunkers or other sources must be handled separately and not pumped into fuel oil tanks.

Fuel oil containing several per cent of water can often be burned successfully, but it is considered unsatisfactory for normal use. Careless handling or accident may increase the water content. It may increase during marine shipment from weather, leaks, and condensation. The water may be "free" water in which case it will settle out in time, or it may form a stable emulsion which will never settle out. Navy specifications limit the amount of B.S. & W., more water being permitted after the oil has been shipped by ocean tanker than at the refinery.

Neither Navy Special nor Grade II fuel oil is inflammable at ordinary temperatures. They become a fire hazard only when something more inflammable acts as a starter. The flash point is set at 150°F. minimum by Navy Specifications. A temperature differential of 15° F. under the flash point is usually ample for a safety factor. When fuel oil is stored at this temperature or below, the vapor although combustible in chemical nature is too dilute to ignite or burn. In other words, the vapor-air mixture in a fuel oil storage tank that is sufficiently under the flash point of the oil is below the lower limit of explosibility.

Two typical advanced base layouts of shore receiving and storage facilities for fuel oil are shown on Figure 1 in the Appendix. The D-4 northern functional component (list of materials) is designed for use in

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Two typical advanced base layouts of shore receiving and storage facilities for fuel oil are shown on Figure 1 in the Appendix. The 1-4 northern functional component (list of materials) is designed for use in northern climates (above approximately 31° N Latitude) where the fuel oil would require heating to facilitate handling. Fuel oil facilities shown on Figure I would be constructed primarily for fueling ships, hence no separate shore distribution system such as would be required to service a steam power plant or steam evaporator plant is included on the drawing. Although the details are not shown on this plan the pipelines and pumps for the tank farm would be so connected as to permit the fueling of ships from shore storage through the same lines used for filling the shore storage tanks.

2. Diesel Oil

Diesel fuel oil of Navy specification is a distillate, a closely controlled and thoroughly refined product, normally pale yellow in color, and comparable to kerosene except for a lower volatility.[3] Navy diesel for high speed engines is in no way comparable to the heavier gas oils and blends which were formerly used for slow speed marine diesels, particularly when air injection was used.

The specific gravity of diesel is of no particular importance and is not covered by specifications. It will average about 0.82 or 40° API.

Diesel oil has a relatively low viscosity and at ordinary temperatures it pumps and flows almost like water. Navy specifications limit the viscosity to 35 to 45 SSU at 100° F. or approximately 0.025 to 0.06 stoke.

Navy diesel also has a relatively low pour point, the pour point being approximately the lowest temperature at which it will flow. However, a rather rapid congealing takes place at the pour point (approximately 0° F.) due to the precipitation of particles of wax and it is, therefore, necessary to heat the oil in cold climates unless a special diesel fuel with lower pour point is provided. This congealing property of diesel oil has no northern climates (above approximately 32° N latitude) where the fuel oil would require heating to facilitate handling. Fuel oil facilities shown on Figure 1 would be constructed primarily for fueling ships, hence no separate shore distribution system such as would be required to service a steam power plant or steam evaporator plant is included on the drawing. Although the details are not shown on this plan the pipelines and pumps for the tank farm would be so connected as to permit the fueling of ships from shore storage through the same lines used for filling the shore storage tanks.

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Cetane number is a measure for defining the ignition quality of a diesel fuel. It is desirable that the ignition lag in a diesel engine be as short as possible to prevent engine knock and rough running. The length of ignition lag depends on the chemical composition of the fuel, and is defined by the scale known as the cetane number - the higher the cetane number the shorter the lag and the better the ignition quality of the fuel. More specifically, the cetane number is the per cent of the hydrocarbon cetane, a compound of excellent ignition qualities, in a mixture with another hydrocarbon of very poor ignition properties, which matches the fuel under test in ignition performance. The cetane number represents essentially opposite characteristics to the octane number of gasoline. In a gasoline engine all the fuel is present before compression, and a long self-ignition lag is desirable to permit the charge to burn progressively and completely from the flame-front started by the spark plug before any part of it detonates as a result of pressure and temperature rise.

Diesel oil is much more penetrating than fuel oil and more penetrating than water as far as pump and valve stem packings are concerned. The fact that it is hard to hold must be remembered in handling operations and care must be exercised to prevent leaks.

Diesel oil should be water-free when used. Aboard ship contact with water is necessary when water ballast is carried in bunker tanks or when the fuel tanks of vessels are provided with automatic fuel oil compensation wherein the ballast water is forced out of the tanks and sea

connections by entering fuel. However, keeping diesel dry in shore handling facilities presents no particular problem. Free water will settle out rapidly, but it may sometimes be necessary to filter a suspension containing a small amount of water such as may occur if oil and water are well churned in a centrifugal pump.

The color of diesel fuel itself is not important, but it provides a very practical and valuable means for checking to insure that contamination has not occurred in handling. The quality of the fuel should be determined by testing if any darkening in color occurs in storage. Contamination of diesel with even a small amount of boiler fuel must be carefully avoided since such contamination may be ruinous in the operation of diesel engines.

Diesel fuel oil is not capable of giving off inflammable vapors at ordinary temperatures unless it has been contaminated with a more volatile product and, therefore, has the same allowable flash point as Navy Special fuel oil. However, due to its lower average boiling temperature it will take fire much more easily, and will support a faster growing, hotter and more persistent fire that may be a great deal harder to extinguish. Also diesel oil spreads more rapidly both on land and water and burns completely whereas boiler fuel oil may go out of its own accord. A spray of diesel oil from a leak or line break may be quite easily ignited by any flame or hot engine exhaust. Thus, while both diesel and fuel oils are relatively non-hazardous from the standpoint of the amount of vapor they release, diesel oil must be recognized as potentially more dangerous and therefore warrants extra care in handling.

Typical naval advanced base facilities for the receiving, storage, and distribution of diesel oil in both tropical and cold climates are shown on Figure 1 in the Appendix. It may be noted that the diesel contaminated by entering fuel. However, keeping diesel dry in shore handling facilities presents no particular problem. Free water will settle out rapidly, but it may sometimes be necessary to filter a suspension containing a small amount of water such as may occur if oil and water are well churned in a centrifugal pump.

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Typical naval advanced base facilities for the receiving, storage, and distribution of diesel oil in both tropical and cold climates are shown on Figure 1 in the Appendix. It may be noted that the diesel tank farms are much smaller in capacity than the fuel oil tank farms in both the D-3 and D-4 components. Included in the distribution facilities for diesel oil is a fueling pier for issue to naval vessels and a loading rack for truck and can fill. Clarifiers are installed on the distribution lines near the points of issue.

3. Gasoline

The properties of gasoline make it the "problem child" among petroleum fuels where handling is concerned. It is highly inflammable, vaporizes readily even at low temperatures, possesses undesirable pumping characteristics and is corrosive to steel pipelines due to the small amount of water and oxygen it always contains. Gasoline containing tetraethyl lead is poisonous when swallowed and the vapors are toxic.

Perhaps the most distinguishing feature of gasoline as far as precautions in handling are concerned is its inflammability. Specifications normally do not require a minimum flash point for gasoline since this temperature would vary greatly depending on the exact composition of the fuel. But obviously the flash point must be well below 0° F. in order to permit easy starting in cold weather. The highly inflammable nature of gasoline is indicated in Table I below.[3]

TABLE I

True vapor pressure of air free sample. P.S.I. at 100°F.	5	6	7	8	9
Lower explosive limit °F.	-24	-31	-38	-43	-47
Higher explosive limit °F.	29	20	15	8	3
Approximate flash point °F.	-11	-19	-26	-32	-36
Concentration of vapor at lower explosive limit % by volume ...	1.7	1.3	1.3	1.3	1.4
Concentration of vapor at higher explosive limit % by volume ...	7.0	7.1	7.3	7.5	7.9

tank farms are much smaller in capacity than the fuel oil tank farms in both the U-1 and U-2 components. Included in the distribution facilities for diesel oil is a fueling pier for issue to naval vessels and a loading rack for truck and can fill. Clarifiers are installed on the distribution lines near the points of issue.

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TABLE I

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Reid vapor pressure of air free sample, lb. at 100°F.					
Lower explosive limit °F.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Higher explosive limit °F.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Approximate flash point °F.	-11	[illegible]	[illegible]	[illegible]	[illegible]
Concentration of vapor at lower explosive limit % by volume ...	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Concentration of vapor at higher explosive limit % by volume ...	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The true vapor pressure usually is from three to ten per cent lower than the Reid vapor pressure depending on composition of the gasoline. Also motor gasoline of a higher vapor pressure is usually supplied to bases in colder climates.

It may be observed from Table I that all gasoline will give off vapors at almost any temperature except perhaps in the most severe arctic conditions, and these vapors may form explosive mixtures with air. In this connection it is the lean vapor mixtures that are dangerous since the concentration of vapor at the higher explosive limit in per cent by volume is relatively low. When gasoline is stored in tanks or other closed containers at usual atmospheric temperatures the concentration of gasoline vapor in air becomes so rich that the tank vapor space is not explosive, but vapor issuing from tank vents and diluted with additional air may become a very serious hazard.

In very cold climates the gasoline may vaporize so slowly that the tank vapor space becomes explosive due to the low concentration of vapors. Such a condition should be suspected whenever the liquid body temperature drops below 20° F. Static electricity build-up in dry air at low temperature may offer a source of ignition at such a time.

Due to the long distance over which heavily concentrated vapors can travel to ultimately find a source of ignition, gasoline spillage is extremely dangerous and must be avoided wherever possible.

Gasoline is difficult to pump under the best conditions, which conditions do not usually exist at naval advanced bases. The volatility of the product makes it difficult to handle even with a moderate suction lift while the absence of lubricating qualities and its penetrating qualities make it difficult to hold with ordinary shaft and valve stem packings, and may result in cutting and abrasion of shaft sleeves and

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Gasoline has a low viscosity of approximately 0.007 stoke at 60° F., a value which is completely off the scale of the Saybolt Universal Viscosimeter. Viscosity, therefore, is a relatively unimportant factor in resistance to pipeline flow when it reaches such low values, while pipe roughness becomes a very important factor.

The corrosive effect of the oxygen and water present in the gasoline not only causes deterioration of steel pipelines and storage tanks, but produces scale and sediment which come out of the lines and thereby damage pumps or contaminate issues unless adequate traps and strainers are used.

No distinction is made between aviation gasoline and motor gasoline as regards handling facilities and precautions. Figure 2 in the Appendix shows the standard layout for a 200,000 barrel gasoline tank farm which may be used for the storage either of motor gasoline or aviation gasoline. Contamination of either type of gasoline is to be avoided. While in fact motor gasoline may become slightly contaminated and yet be usable, it is obvious that gasoline issued to aircraft must meet specifications in all respects.

4. Jet Fuel

As in the case of gasoline, specifications for jet fuel have undergone changes in an attempt to meet requirements for better performance of aircraft turbines and jet engines. The fuel currently used is known as Grade JP-5.[4] While not as volatile as gasoline and also differing from gasoline in other respects, there can be little difference in the handling facilities and operations of these two fuels.

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IV. SHORE FACILITIES FOR HANDLING BULK PETROLEUM FUELS AT NAVAL ADVANCED BASES

Advanced base fuel handling systems include facilities for receiving, storing and distributing one or more of the fuels discussed in section III. Bulk fuels are received from tankers, stored in tank farms and distributed for issue on the base or to vessels of the fleet.

The first consideration in the design of an advanced base fuel system is tanker turn around time. It is imperative that tankers be unloaded in the shortest possible time, not only for reasons of economy but also for security reasons in time of war. Ways and means of reducing tanker turn around time are, therefore, being given continuing study by the Navy.

In order to receive from tankers and issue to ships the sea loading lines must be in condition to permit the flow of fuels at sufficient rates and without leakage. Failure of these lines during and after World War II was not uncommon and improvement in materials and construction techniques are therefore needed.

Protection of pipelines and tankers from corrosion can be measurably improved; corrosion protection for World War II facilities was practically nil. Cathodic protection by means of anodes and brush-on coatings for protection against oxidation should be provided. Also the substitution of corrosion-resistant materials for steel should be considered. Large losses of fuels due to corrosion failures in pipelines and tanks have been incurred.

IV. OTHER FACILITIES FOR HANDLING BULK PETROLEUM FUELS AT NAVAL ADVANCED BASES

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Another cause of appreciable loss of fuel, particularly gasoline, is evaporation which could be practically eliminated by the installation of vapor recovery systems in conjunction with gasoline tank farms. A standard vapor recovery system of the breather balloon type is considered the most practicable solution to this problem. Breather balloons are available commercially in a wide range of types and capacities.

The site for a tank farm is important for a number of reasons. From an operational standpoint, it should be located so that full advantage can be taken of the elevation of the tanks and the product dispensed from storage by gravity. In some cases, World War II advanced base tank farms were so situated that it was necessary both to pump into and out of storage, while in other cases tank farms were so located that the tankers' pumps could pump direct to storage without the aid of boosters and yet the tanks were high enough that the fuel could be dispensed by gravity. Due to commonly severe climatic conditions and relatively inexperienced personnel, maintenance of advanced base mechanical installations is a problem and it is highly advantageous to eliminate booster pumps and similar installations if at all practicable.

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A. Receiving Facilities

Receiving facilities for an advanced-base bulk-fuel handling system commence with the blind flange on the offshore end of the submarine hose (See Figure 3, Appendix) terminate at the ring header in the tank farm (See Figure 1, Appendix) and include all hose, pipelines, pumps valves and fittings between these two points.

1. Sea Loading Lines

As previously indicated most advanced-base bulk-fuel storage plants are at least initially dependent on sea loading lines for the receipt of fuel from tankers. Figure 3 in the Appendix shows construction details for 6", 8" and 12" sea loading lines with cargo hose. Commercial oil companies have for years successfully constructed and operated submarine pipelines for tanker loadings. Most lines of this type are constructed of extra heavy pipe with protective coating, although some lines have been laid bare. Union Oil Company's sea loading line off the beach at Ventura, California is a bare line that has been in service for approximately twenty years. A few years ago cathodic protection was installed on this line, and indications are that the life of the line will be extended appreciably by this protection.

Experience with sea loading lines at World War II naval advanced bases in the Pacific Ocean areas was not as satisfactory in general as in the case cited above. Failures during the first year or two of operation were common although standard weight or heavier pipe was used almost without exception. Several methods were used for installing the submerged line depending on the type of bottom present, the personnel and equipment available and also upon wave, tide and wind conditions.[5] One method used consisted of welding sections of pipe together on shore,

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It will be noted from Figure 3 in the Appendix that the under water lines fan out to present the connection in line with the side of a ship moored in the fueling berth. Where fuel oil, diesel oil and gasoline lines are all installed, the fuel oil line is located in the center with the diesel oil line toward the moorings or stern and the gasoline line toward the bow as tankers carry their gasoline in the forward tanks and their diesel aft.

To give long service such as the Union Oil Company line, submarine pipelines should be properly placed on bottom, and given frequent inspection. Such was probably not the case with sea loading lines constructed at advanced bases under wartime conditions. In order to place sea loading lines in operation as quickly as possible, they were often hurriedly laid along the bottom with no trenching and little if any additional weight provided. The lines were, therefore, subject to movement by the ocean currents and early failure frequently resulted from abrasion where the pipe lay across coral reefs. Blasting of a trench in the reef for the line and adequately weighting the pipe is necessary if floating the sections out on barges where they were welded together, weighted and sunk in place. Another method which was also used consisted of welding the hose adapter on end of the first joint of pipe and bolting on a blind flange for water tightness; welding on additional joints of pipe on the beach and pushing the line into the water until the desired length was obtained. In using the latter method no additional floats are required for a 12" line inasmuch as the empty line will float, but 8" and smaller diameter lines require additional buoyancy for floating into position. Oil drums are usually readily available and make satisfactory floats. Lowering of the pipe can be accomplished by shooting holes in the drums.

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Little or no inspection was provided these sea loading lines and line failures were often not discovered until a tanker arriving to load or unload found the cargo hose missing, or upon commencing to pump through the line observed fuel coming to the surface of the water. Under these conditions, fueling operations are not only disrupted, but oil and particularly gasoline on the surface of the water becomes a fire hazard to the ship. Hence, the tendency was to replace submarine fuel lines with more reliable fuel piers or docks, although the sea loading lines have three advantages over waterfront fueling structures, viz. (1) speedier construction, (2) less materials and labor required for installation and (3) capable of being laid out into deep water where largest ships can be moored. The berthing and draught of new super-tankers is definitely a problem where water front fueling facilities are concerned, and it may be necessary in certain places to use sea loading lines for discharing their cargo.

Fuel receiving facilities at advanced bases should be such as will permit tankers to discharge their cargo at the maximum rate, thereby reducing the turn around time to the minimum. Improved materials and equipment, greater flexibility, higher working pressures and improved cold weather characteristics are factors which make possible the unloading of a T-2 tanker at a rate in excess of 8000 barrels per hour. To mention one improvement in this connection - a new light-weight seven-inch cargo such failures are to be prevented. Another source of early failure was the parting of the cargo hose at the end of the pipe due to improperly connecting or mooring the hose. Hose failures of this nature can be minimized by carefully following the connection and mooring details shown on [illegible] 3 in the Appendix when placing the hose.

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2. Booster Pumps

Advanced base plans and material lists provide for a booster station to be used on receiving and to be located on or near the beach. Figure 4 in the Appendix shows the standard hookup for booster pumps. Where the receiving lines are short and the storage tanks are not appreciably higher than sea level, the pressure of the ship's pumps may be sufficient to put the product into the tanks without intermediate boosters. The possibility of eliminating the booster pumps on receiving is, therefore, one of the factors to be considered in selecting pipe sizes and tank farm location. On the other hand, it may be more desirable to boost the products to storage and elevate the tanks in order to dispense by gravity. A third possibility is the ideal condition wherein no booster pumps are required. To meet this condition, the tanks must be situated low enough so that filling can be accomplished without the aid of boosters and yet have sufficient elevation to permit dispensing by gravity.

The handling of gasoline at advanced bases during World War II was complicated by a shortage of pumps that were satisfactory for boosting gasoline. Several types of centrifugal pumps were available, the most common of which was the portable unit comprised of a gasoline engine driven pump rated at 350 gpm at 125 psi. This pump was very satisfactory for pumping Navy Special fuel oil, but soon developed packing gland leaks when placed in gasoline service. It was observed that some gasoline booster stations were equipped with pumps designed exclusively for water

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*Information regarding the development of the hose is classified material and, therefore, not available for publication.

service wherein a small stream of the liquid pumped is used to cool the shaft bearings. Even after somewhat elaborate pumps were installed at these stations, the leaking gasoline presented a very serious fire hazard.

The Army 1000 gpm gasoline pumps and the Army "pup pumps" called for in Figure 4 in the Appendix are specially designed for gasoline service, and from limited observation they appear to be satisfactory. The stuffing boxes on these pumps are considerably longer than conventional centrifugals and a special packing for gasoline service is used.

The plan of the piping layout for booster stations (Figure 4, Appendix) permits a two-way operation, i.e. boosting the fuel to storage tanks or fueling ships from the tanks through the sea loading lines.

3. Pipelines

Pipelines used on receiving are pressure lines. Coated pipe was the exception, rather than the rule, for sea loading lines in World War II. Even when coated pipe was supplied the materials and equipment for field coating the joints were usually not available. In a sense, coated pipe with bare joints is worse than no coating at all due to the corrosion concentration at the breaks in the coating and hence such a line usually fails sooner than one consisting entirely of bare pipe. Some improvised field coating of submerged lines was attempted, usually involving the use of tar or road asphalt, neither of which was very satisfactory.

No cathodic protection is known to have been installed at temporary advanced bases constructed during the war. Installation of magnesium anodes on underwater lines at the beach would be a relatively simple procedure, and would probably cathodically protect the pipe for a distance of several hundred yards from shore, perhaps even for its entire length.

From the beach to the tank farm light weight, spiral weld, grooved coupling steel pipelines are satisfactory except perhaps under road and stream crossings. (Functional components for 200 foot and 400 foot stream crossings have been developed by the Bureau of Yards and Docks). The pipe should be laid on the surface wherever practicable to speed construction and eliminate electrolytic corrosion. Heavy timber skids, or logs locally available will serve to support the pipe above the ground surface; fabricated steel or concrete supports are usually not warranted. Sufficient slack should be in the lines to take care of expansion and contraction of the metal with temperature changes. Also supports or skids should be long enough to allow for lateral movement of the pipe as it expands and contracts.

With the pipe above ground, protection from oxidation may be accomplished by applying a brush-on coating as often as necessary. Where the line must go underground cathodic protection can be provided by magnesium anodes. The use of rectifiers with ground beds for cathodic protection would normally not be practicable for fuel systems of the type under discussion.

Pipelines should be marked frequently with painted bands in accordance with the standard Navy color chart,[3] viz. bright blue for aviation gasoline lines, orange for lines carrying motor gasoline, green band for diesel and yellow band for fuel oils. Also block gates should be installed at intervals along pipelines of considerable length so that sections of the line may be isolated for repair in the event of rupture or damage from enemy action.

In addition to adequate working pressure, desirable characteristics of pipe are (1) light weight and (2) suitability for rapid installation. Materials being tested as possible substitutes for steel

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In addition to adequate working pressure, desirable characteristics of pipe are (1) light weight and (2) suitability for rapid installation. Materials being tested as possible substitutes for steel pipe include aluminum, magnesium, plywood, honeycomb and reinforced plastic. Plywood and honeycomb plastic have been determined to be unsatisfactory.

Although it has been done successfully, the pumping of different products through the same line should generally be avoided at advanced bases. In the event such an operation is attempted only clean products should be pumped, and turbulent flow must be maintained to avoid excessive contamination from mixing. Also inexperienced operating personnel must be closely supervised for an operation of this type to be successful.

B. Storage Facilities

In addition to tankage, storage facilities include the pipe in the ring headers, transfer pumps and accessories such as valves and fittings. Storage for ready issue like the four 1000 barrel tanks shown in Figure 2 in the Appendix are considered part of the distribution facilities. In other words, the storage facilities comprise that part of the system between the tail gate on the receiving lines and the header gate on the distribution lines.

1. Tanks

As previously stated, the advanced base fuel tanks built during World War II were mostly of the bolted type, particularly in the Pacific theatre of operations. An exception was the tank farm on Bennett Island in the Kwajalein Atoll. Here the storage consisted of large capacity (approximately 55,000 barrels) riveted steel tanks. These tanks, originally a part of the Teapot Dome tankage erected in the 1920's were dismantled and reconditioned prior to being shipped to the Pacific. A few of the Teapot Dome tanks were also shipped to Guam. During 1947 on Guam the wartime bolted tanks began to fail, and the supply of new bolted tanks had been exhausted. Gasoline storage was becoming critically low when materials for two 80,000 barrel riveted tanks complete with rivets and coal for the forge were discovered in an inactive storage area. The materials were reclaimed from the jungle and the tanks hurriedly erected to provide the much needed gasoline storage.

A few welded steel storage tanks of 10,000 to 50,000 gallon capacity were scattered around over the Pacific, but these tanks were used primarily for ready issue storage.

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In addition to tankage, storage facilities include the pipe in the ring headers, transfer pumps and accessories such as valves and fittings. Storage for ready issue like the four 1000 barrel tanks shown in Figure 2 in the appendix are considered part of the distribution facilities. In other words, the storage facilities comprise that part of the system between the tail gate on the receiving lines and the header gate on the distribution lines.

1. Tanks

As previously stated, the advanced base fuel tanks built during World War II were mostly of the bolted type, particularly in the Pacific theatre of operations. An exception was the tank farm on Bennett Island in the Kwajalein Atoll. Here the storage consisted of large capacity (approximately 57,000 barrels) riveted steel tanks. These tanks, originally a part of the Lend Lease tankage erected in the 1920's were dismantled and reconditioned prior to being shipped to the Pacific. A few of the Lend Lease tanks were also shipped to Guam. During 1947 on Guam the wartime bolted tanks began to fail, and the supply of new bolted tanks had been exhausted. Gasoline storage was becoming critically low when materials for two 10,000 barrel riveted tanks complete with rivets and coal for the forge were discovered in an inactive storage area. The materials were reclaimed from the jungle and the tanks hurriedly erected to provide the much needed gasoline storage.

A few welded steel storage tanks of 10,000 to 20,000 gallon capacity were scattered around the Pacific, but these tanks were used primarily for ready issue storage.

Bolted tanks were, with few exceptions, standard API tanks of either 1000 or 10,000 barrel capacity. The 1000 barrel tanks were predominantly the low type (approximately 30 feet in diameter and 8 feet high) but the high type (approximately 21 feet in diameter and 16 feet high) were also used. The 10,000 barrel tanks, approximately 55 feet in diameter and 24 feet high, were normally provided with manufacturer's standard gaskets suitable for use with fuel oil and diesel oil, but not suitable for gasoline. It was, therefore, necessary that special gaskets be obtained if the tanks were to be used for gasoline storage - the type of gasket material with which the 1000 barrel tanks were normally equipped.

Figure 5 in the Appendix is the standard plan for the erection and connection of a 1000 barrel tank at an advanced base. The layout for a 10,000 barrel tank is similar.

The tank foundation of 6" sand cushion on natural ground or compacted fill is entirely adequate, in fact is more satisfactory than many of the more elaborate tank foundations which were constructed at advanced bases. Some of the more common types of these foundations were concrete, asphalt, sand cushion with concrete retaining ring and oiled sand. Where clean sand can be obtained, and it is generally about the most plentiful material locally available, the concrete and asphalt foundations are not recommended because extra materials, manpower and time are required. The use of a ring to retain the sand is normally not necessary - in some unusual cases it might be justified. Spraying the sand with asphalt, tar, or even oil has no particular advantage, in fact may accelerate corrosion of the tank bottom by holding water between the steel plates and the sand cushion. The foundation should be kept dry and nothing does the job quite as well as clean, unconsolidated sand.

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Bottom leaks were the most common cause of tank failure. Some of these leaks were undoubtedly caused by faulty erection, but the large majority were due to corrosion. No corrosion protection was provided most of the tank bottom, either inside or outside the tanks. Coating of the bottom and up about a foot along the inside of the tank walls will provide some measure of protection from the active electrolytes in the B.S. & W. Paint or coating developed for this purpose are manufactured by a number of companies e.g. U.S. Stoneware and United Chromium, Inc. This type of coating must, of course, not be soluble in petroleum fuels. Cathodic protection of the underside of the tank bottom may be provided by magnesium anodes. In order to insure cathodic protection of the entire bottom of the tank, the plates should be electrically bonded together with a low resistance connection when installing the anodes.

Tanks with minor bottom leakage may sometimes be retained in service for a while by use of a water pad. Water may be pumped in through the bottom drain connection and no appreciable mixing with the product will occur. The water pad should be from three to six inches in depth, enough to prevent leakage of the fuel from the tank, but with the water level always well below the tank outlet which is normally about 12" above the tank bottom. The water pad cannot be used with an elbow inside the tank as shown on the detail of the typical tank connections in Figure 5 in the Appendix. It has been observed that this elbow has seldom been installed when erecting bolted tanks.

If the walls and roofs are reasonably good on a tank with a faulty bottom, a concrete deck of three or four inches in thickness may be poured to serve as a new bottom.

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Direct oxidation of tank roofs and walls in the presence of air and moisture is a source of corrosion that can be effectively eliminated by painting.

In the April, 1953 issue of "World Oil" there was reported a new type of corrosion resistant oil storage tank offered by Murdock Tank and Manufacturing Company.[6] The new bolted tanks are made of reinforced plastics, combining Fiberglas mat and Laminac polyester resin and range in capacity from 250 to 3000 barrels. Fiberglas-Laminac material is reported impervious to damage by hydrogen sulfide gases, salt water and electrolytic action. The new material also reduces vapor losses common in metal tanks as it has thermal conductivity of about 1/20 that of steel. Furthermore, the plastic material does not expand and contract appreciably under varying temperature extremes, which minimizes temperature stresses at the bolted seams. The cost of this new type of tank is not stated.

Bolted tanks have a tendency to leak at the seams. Tightening of bolts may be adequate to stop seam leaks, however, if a leak is due to excessive tightening of the bolts and a squeezing out of the gaskets, then little can be done except to replace the damaged gasketing. Tests are being conducted on materials designed to prevent drying out of gaskets when tanks are empty.

The berm around a fuel tank must be properly drained. In the event water is allowed to accumulate inside the fire wall or berm there is danger of floating light weight tanks off their foundation.

2. Pipelines

Interconnecting pipelines within the tank farm should be of the light weight, quick coupling type. Construction features discussed under receiving facilities are applicable and are not repeated.

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The berm around a field tank must be properly drained. In the event water is allowed to accumulate inside the fire wall or berm there is danger of floating light weight tanks off their foundation.

2. Pipelines

Interconnecting pipelines within the tank farm should be of the light weight, screw coupling type. Construction features discussed under receiving facilities are applicable and are not repeated.

3. Transfer Pumps

Connections for advanced base transfer pumps are detailed on Figures 6 and 7 in the Appendix respectively. Figure 6 shows a gasoline transfer pump with 8" ring header, and Figure 7 shows a transfer pump for fuel and diesel oil with 12" ring header. The pumps are so connected in each case that they can be used for transfer of product between tanks, to ready storage for issue or back through the sea loading lines.

4. Breathing Losses

Standard bolted steel tanks are equipped with fixed conical roofs, and the gas within the tank is subjected to appreciable variations in temperature between day and night resulting in material expansion and contraction changes in gas volume. With temperature increase the gas expands, and some of it must be released from the tank for pressure relief. Then with temperature decrease the vapor in the tank contracts, and air must be admitted to avoid collapse of the roof. Also when filling, the vapor must be allowed to escape in order to make room for the liquid, and when pumping out of the tank air must be allowed to enter in order to prevent a vacuum. This condition presents no particular problem in the storage of fuel and diesel oil, but with a volatile fuel such as gasoline, evaporation due to temperature changes and pumping may result in substantial losses of product. A very limited number of bolted tanks at World War II advanced bases were provided with pressure and vacuum relief valves. Although not wholly effective in eliminating evaporation losses, the pressure and vacuum relief valves were a step in the right direction. It does not appear practicable to change the roof design of bolted tanks for advanced base use to any of the several types which reduce vapor losses such as the breather roof, "water top" roof, or "floating" roof. However, a vapor recovery system for gasoline tank farms is a possible

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Based on this assumption, the breathing losses from a 10,000 barrel tank would amount to approximately 400 barrels of gasoline in a year or approximately 1200 barrels per year from a battery of ten 1,000 barrel, 30 foot diameter tanks. Elimination of 90 per cent of these losses would result in considerable savings. Installation of the breather balloon vapor recovery system is simple and the maintenance costs negligible.

In addition to the balloon breathers available commercially, it appears feasible to use the 1000 barrel pillow-shaped tank of pliable material mentioned earlier. The tank could, therefore, serve a dual purpose, i.e. provide bulk storage capacity during amphibious operations and then be converted to a gas holder when tank farms have been erected. Again based on the assumptions in the preceding paragraph, one of the 1000 barrel pillow-shaped tanks would provide ample gas holder capacity for one 10,000 barrel gasoline storage tank or twelve 1,000 barrel storage tanks.

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By using plastic pipe to connect the gas holder with the storage tank practically no additional steel would be required for the vapor recovery system.

5. Fire Control

Advanced base fuel systems constructed during World War II were provided with few, if any, fire control devices. Hand and cart type CO_2 and foam extinguishers were plentiful. Although their importance should not be overlooked, these could hardly be considered effective fire control devices. Study and research is being given extinguishing agents including CO_2 chemical foam, water fog, fog-foam, dry powder, bromotri-fluromethane, and water additives.* Also experiments are being conducted with a view to providing greater fire protection through the basic foam generation for on-surface and sub-surface application.

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C. Distribution Facilities

Distribution facilities include all pipelines, ready storage, pumps, and appurtenances which are used to distribute the product for issue. As previously mentioned, the issues of fuel oil are to surface craft or for boiler fuel ashore. Issues to surface craft are made by means of the sea loading lines, or in some cases, a fueling pier. Issues to boiler plants ashore, if such plants exist, would be through pipelines and ready storage constructed for that purpose.

Dispensing of diesel fuel may be either to naval vessels or equipment and power units ashore. In addition to the sea loading lines, small fueling piers are usually provided for issue to surface craft, and tank truck and can filling racks are provided for shore issues, as shown on Figure 1 in the Appendix. Diesel powered equipment is, in turn, fueled from the tank truck.

Gasoline may be dispensed to naval vessels through the sea loading lines or to tank trucks ashore as shown in Figure 2 in the Appendix. Gasoline issuing facilities may also be provided for the small boat docks.

1. Pipelines

Light-weight steel pipe has been used almost exclusively in temporary advanced base fuel distribution systems. Inasmuch as steel is critical in wartime, use of a substitute material for distribution lines would be desirable. Where pressures and capacities will permit light-weight plastic pipe such as described in the November, 1952 issue of "World Oil" may be used for distribution lines.[8] Three-inch pipe of this clear plastic weighs only 0.88 lb/ft., and some 4000' of 2 and 3 inch has been laid by a two-man "spread" in a matter of several hours. Additional

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2. Pumps

Wherever feasible, dispensing should be done by gravity from the main storage area. By elimination of the dispensing pump the operation is simplified, and by elimination of the ready gasoline storage evaporation losses are reduced.

As indicated in Section III, B, 2, location of the tank farm may involve a decision in the field as to whether it is better to eliminate the booster pumps on receiving or on distribution, or whether the tank farm can be so situated that booster pumps will not be required on either receiving or dispensing.

3. Water Separators and Clarifiers

Water separators should be provided for gasoline dispensing units such as shown on Figure 8 in the Appendix and clarifiers for diesel such as shown on Figure 9 in the Appendix. It has been observed that frequently water separators and clarifiers do not perform the functions for which they are designed due to lack of attention and maintenance. To be effective this equipment must be drained regularly and otherwise properly cared for.

4. Safety Precautions

Leaks in the vicinity of issuing facilities should be promptly repaired, no smoking regulations must be rigidly enforced, spark proof nozzles and tools must be used, explosion proof electrical fixtures must advantages of this pipe are its inertness to rust, its ability to withstand electrolysis and its flexibility which eliminates the necessity for making bends or angles. Also the pipe, being smooth, is almost frictionless, and has for a given size of pipe a flow capacity ranging from 18 to 25 per cent greater than that of steel pipe.

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For a safety program to be effective, personnel must be safety conscious and thoroughly indoctrinated in the use of safety devices and safety measures. Indifference and carelessness cannot be tolerated.

V. SUMMARY AND CONCLUSIONS

Deficiencies existed in the type of shore fuel handling facilities erected at naval advanced bases during World War II. The major deficiencies and possible remedial measures are summarized as follows:

(1) Turn around time for tankers was in some cases excessive. Improved materials and equipment have been developed which make it possible to discharge a T-2 type tanker at a rate in excess of 8000 barrels per hour. Equipment on existing tankers should be modified as practicable to include the latest improvements; new tankers obviously will be provided with the most modern pumps, hoses and accessories.

(2) Failure of sea loading lines after only a short period of service seriously limited the usefulness of some of the systems. The useful life of sea loading lines can be lengthened by protecting the pipe against abrasion and corrosion. Providing a ditch by blasting or other means where the line crosses rough ocean bottom or coral reefs and adequately weighting the pipe will alleviate the abrasive effect of the rocks and the coral. Coated pipe is desirable for sea loading lines; however, it

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should not be used unless materials are available for properly coating the joints. Cathodic protection can be applied by means of anodes to mitigate electrolytic corrosion of the steel pipe.

(3) The majority of booster stations installed presented operational and maintenance problems. Pumps were often not suitable for the type of service in which they were used and mechanical failures were frequent. Only pumps designed for the fuel to be handled should be installed to prevent leakage and attendant fire hazards. Every consideration possible should be given to the layout and location of tank farms with a view to eliminating the need for booster stations.

(4) Little protection was provided against corrosion failures in shore pipelines and tanks. Corrosion failures in steel pipelines can be greatly reduced by supporting the lines on skids aboveground and applying brush-on coatings. Where it is necessary to lay the pipe underground, cathodic protection can be applied by means of anodes. Brush-on coatings can be applied to tanks to reduce oxidation and corrosive tendencies of electrolytes. Anodes can be used to cathodically protect the underside of tank bottoms.

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(5) Gasoline losses due to evaporation were of considerable magnitude. Evaporation losses can be appreciably reduced by installation of balloon breather type vapor recovery systems. Standard balloon breather equipment in a wide range of capacities is commercially available. Also a vapor recovery system using collapsible, pillow-shaped tanks and plastic pipe is considered feasible. An apparent advantage of the pillow-shaped tanks is that they may be first used for interim fuel storage and later converted to gas holders.

(6) Fire control devices were generally inadequate. Experimental work is being done by the Navy on improved fire control equipment and procedures.

(7) Steel is a critical material in time of war. Also steel pipe and tanks are heavy items to ship. Light-weight plastic pipe and tanks have been developed which can be substituted for steel in distribution systems, where capacities and pressures will permit.

While advanced bases of the future will probably have the same functions as the bases of World War II, their characteristics may be quite different. The type of bases to be built will be determined by many factors such as the capabilities of the enemy, the characteristics of the theatres, the general strategic plans, tactical development of new weapons, and the strength and disposition of the enemy forces. The most complex type of advanced base is that in which the ground, air and naval forces

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Because the effectiveness of any offensive is greatly increased by decreasing the distance from which the offensive is launched, it will always be advantageous to operate from advanced bases as close as possible to the enemy. The ever increasing demand for greater fire power and greater mobility in all our forces means greater mechanization, a greater need for technical improvements and for maintenance personnel and facilities. This, in turn, increases the already high ratio of support forces to combat forces, which means that it is more important than ever that our advanced bases be substantial in their productive support capacity. An efficiency much higher than that achieved in the past is absolutely essential if advanced bases are to fulfill their mission in the future.

New wars are not won solely on the experience gained and lessons learned from previous wars. However, elimination of the technical problems encountered in the construction and operation of the bulk fuel handling facilities at naval advanced bases both during World War II and the post war years is obviously the first step in providing improved facilities for the next war.

It is highly probably that a number of so-called "temporary" fuel systems erected at advanced bases during wartime may of necessity remain in service an indefinite period of time after the cessation of hostilities. It is, therefore, concluded that these facilities should be designed and constructed not only to operate with maximum mechanical efficiency and minimum loss of fuels handled, but also to give the maximum length of service practicable.

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A. Recommendations

The following recommendations relating to advanced base fuel facilities are made with a view to attaining the objectives cited on the preceding pages, viz. improved mechanical efficiency, minimum loss of fuel handled and maximum length of service.

(1) It is recommended that sea loading lines be laid in a ditch across areas of rough bottom or coral reefs and that the pipe be adequately weighted.

(2) Cathodic protection by means of magnesium anodes is recommended for underwater and underground steel pipelines and tank bottoms.

(3) It is recommended that pump stations be eliminated wherever praticable to reduce waste, fire hazards and maintenance problems.

(4) It is recommended that the inside of tanks be protected from corrosion by the application of the proper coating materials.

(5) It is recommended that tank surfaces and above-ground pipelines be protected from oxidation by painting and brush-on coatings.

(6) Vapor recovery systems of the balloon breather type are recommended for installation in conjunction with gasoline storage. Breather balloons are available commercially, or collapsible tanks of pliable material used for interim fuel storage probably can be converted to gas holder service.

A. Recommendations

The following recommendations relating to advanced base fuel facilities are made with a view to attaining the objectives cited on the preceding pages, viz. improved mechanical efficiency, minimum loss of fuel handled and maximum length of service.

(1) It is recommended that sea loading lines be laid in a ditch across areas of rough bottom or coral reefs and that the pipe be adequately weighted.

(2) Cathodic protection by means of magnesium anodes is recommended for underwater and underground steel pipelines and tank bottoms.

(3) It is recommended that pump stations be eliminated wherever practicable to reduce waste, fire hazards and maintenance problems.

(4) It is recommended that the inside of tanks be protected from corrosion by the application of the proper coating materials.

(5) It is recommended that tank surfaces and above-ground pipelines be protected from oxidation by painting and brush-on coatings.

(6) Vapor recovery systems of the balloon breather type are recommended for installation in conjunction with gasoline storage. Breather balloons are available commercially, or collapsible tanks of pliable material used for interim fuel storage probably can be converted to gas holder service.

(7) Light-weight plastic pipe and tanks are recommended as substitutes for steel where feasible.

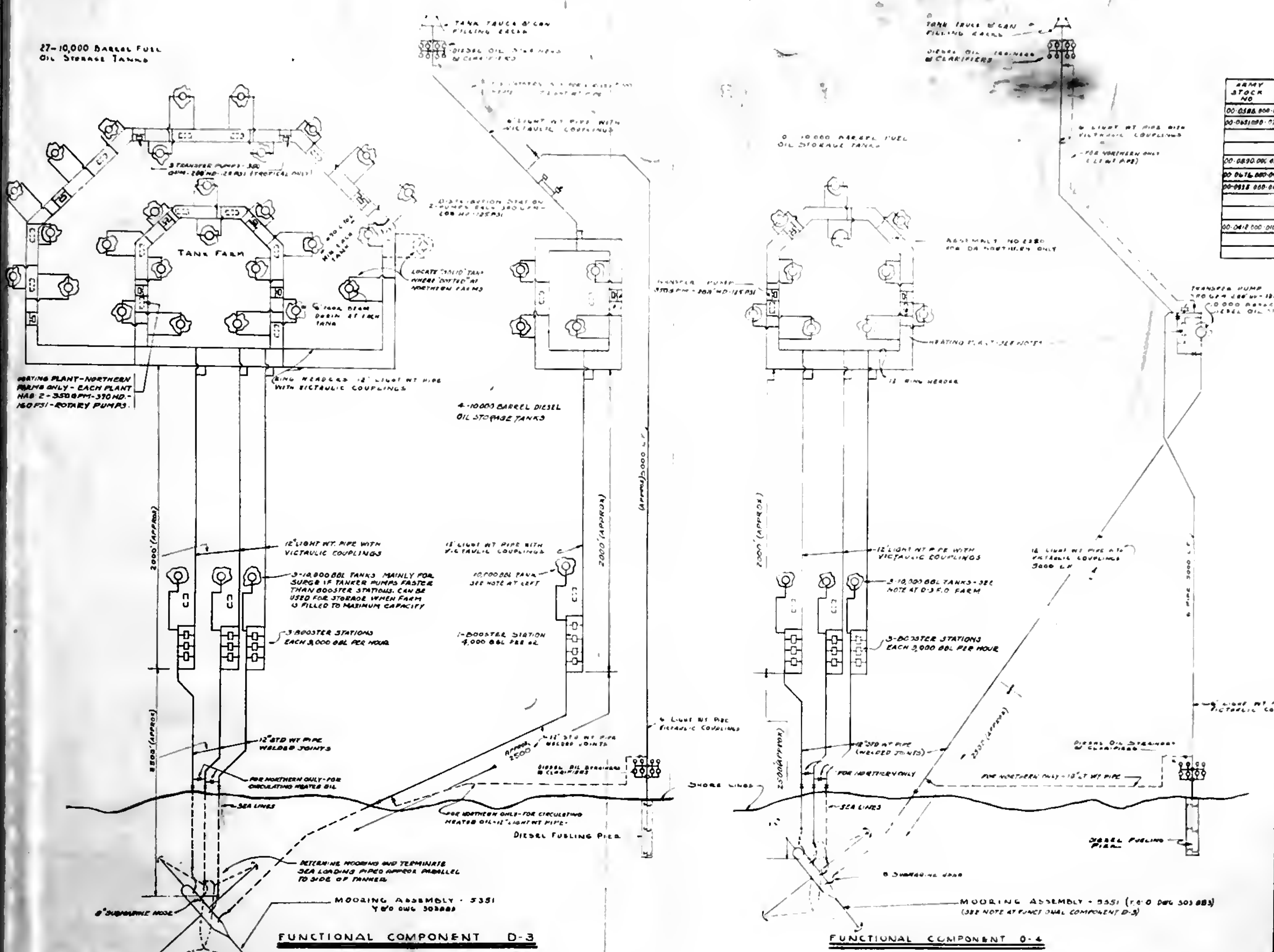
It must be realized that in wartime problems of supply and personnel are involved in the construction and operation of advanced base fuel handling facilities; if the materials called for on the plan are not available, then it is necessary to improvise, and if experienced personnel are not available for operation of the facilities then inexperienced personnel must be used.

In general no attempt has been made to analyze problems related to these two factors.

(7) Light-weight plastic pipe and tanks are recommended as substitutes for steel where feasible.

It must be realized that in wartime problems of supply and personnel are involved in the construction and operation of advanced base fuel handling facilities; if the materials called for on the plans are not available, then it is necessary to improvise, and if experienced personnel are not available for operation of the facilities then inexperienced personnel must be used.

In general no attempt has been made to analyze problems related to these two factors.



ARMY STOCK NO	NAVY ASSEMBLY NO	D-3 NORTHERN DESCRIPTION	QUANTITY DIESEL	QUANTITY FUEL	Y&D DOCKS DRAWING NUMBER
00-0588.000-00	5351	Mooring (60 feet depth of water	—	1	303,883
00-0651.000-070	2202	Sea Loading Lines, 12"	1	3	398804
	2223	Booster Station, 4 Pumps 12"	1	—	398805
	2221	Booster Station, 3 Pumps 12"	—	3	398805
00-0890.000-050	2206	Tank 10,000 Bbl 12"	5	30	398806
00-0616.000-010	2211	Distribution Station, Diesel	1	—	398810
00-0935.000-010	2214	Rack	1	—	398811
	2215	Clarifier	1	—	398812
	2216	Diesel Pier	1	—	398812
00-0412.000-010	2219	Distribution Pipe 5,000 feet/6"	1	—	398910
	2220	Fuel and Diesel Oil Heating	3	45	282267-8 / 258303-3-4 / 283930-1
	2022	Tool Kit	1	10	

ARMY STOCK NO	NAVY ASSEMBLY NO.	D-3 TROPICAL DESCRIPTION	QUANTITY DIESEL	QUANTITY FUEL	Y&D DWG NO
[illegible]000-010	5351	Mooring (60 Ft Depth of water)	—	1	303,883
[illegible]000-010	2202	Sea Loading Lines, 12"	1	3	390,904
	2223	Booster Station, 4 Pumps 12"	1	—	390,905
	2221	Booster Station, 3 Pumps 12"	—	3	390,905
[illegible]000-050	2206	Tank 10,000 Bbl. 12"	5	30	390,906
	2210	Transfer Pump 12"	1	9	390,909
[illegible]000-040	2211	Distribution Station, Diesel	1	—	390,910
[illegible]000-010	2214	Rack	1	—	390,911
	2215	Clarifier	1	—	390,912
	2216	Diesel Pier	1	—	390,912
[illegible].0412.000-010	2219	Distribution Pipe 5000Ft/6"	1	—	398,910
	2022	Tool Kit	1	10	

ARMY STOCK NO	NAVY ASSEMBLY NO	D-4 TROPICAL DESCRIPTION	QUANTITY DIESEL	QUANTITY FUEL	Y&D DWG NO
00-4588.000-00	5351	Mooring (60 Ft Depth of Water)	—	1	303,883
00-0651.000-010	2202	Sea Loading Lines, 12"	1	3	390,906
	2221	Booster Station, 3 Pump 12"	—	3	390,905
00-0890.000-050	2206	Tank 10,000 Bbl 12"	1	13	390,906
	2210	Transfer Pump 12"	1	3	390,909
00-0935.000-010	2214	Rack	1	—	390,911
	2215	Clarifier	1	—	390,912
	2216	Diesel Pier	1	—	390,912
	2210	Distribution Pipe 5000 Ft/12"	1	—	390,910
00-0412.000-010	2219	Distribution Pipe 5000 Ft/6"	1	—	390,910
	2022	Tool Kit	1	3	—

ARMY STOCK NO	NAVY ASSEMBLY NO	D-4 NORTHERN DESCRIPTION	QUANTITY DIESEL	QUANTITY FUEL	Y&D DWG NO
00-0588.000-00	5351	Mooring (60 Ft Depth of water)	—	1	303,883
00-0651.000-010	2202	Sea Loading Line 12"	1	3	390,904
	2221	Booster Station 3 Pump 12"	—	3	390,905
00-0890.000-050	2206	Tank 10,000 Bbl 12"	1	13	390,906
00-0935.000-010	2214	Rack	1	—	390,911
	2215	Clarifier	1	—	390,912
	2216	Diesel pier	1	—	390,912
	2210	Distribution Pipe 5000 Ft/12"	1	—	390,910
00-0412.000-010	2219	Distribution Pipe 5000 Ft/6"	1	—	390,910
	2220	Fuel Oil and Diesel Oil Heating	1	7	282267-8 / 258303-3-4 / 283930-1
	2022	Tool Kit	1	3	—

Note -
Moorings & Submarine Lines to be Located So that Tanker Heads Into Wind Or Swells

NOTES

1. [illegible] Indicates Heating Plants for Northern locations only
2. For Heating Plant connections to mains see Y&D Dwg No. 283931
3. Pipe, valves & fittings for northern heated oil circulation will be available from tank assemblies where the tanks are used for surge purposes.
4. Diesel farm shall be located on right or left side of fuel oil farm to best suit direction of tanker mooring & oil hose connections.

REFERENCE DRAWINGS
Y&D 398,900 TO 398,913 INCL.
303,883
282267-282268
258102-258103
283334-283430
283931

APPROVED BY BUREAU OF ______
DATE ______ BY ______

FUNCTIONAL COMPONENT

NAVY DEPARTMENT — BUREAU OF YARDS & DOCKS

Prepared by Willcotts
Traced by [illegible]
Checked by C.D.M. & R.K.

ADVANCED BASES
ARMY-NAVY FUEL FACILITIES
"D" COMPONENTS
FUEL & DIESEL OIL TANK FARMS

Approved Aug. 30, 19[illegible]

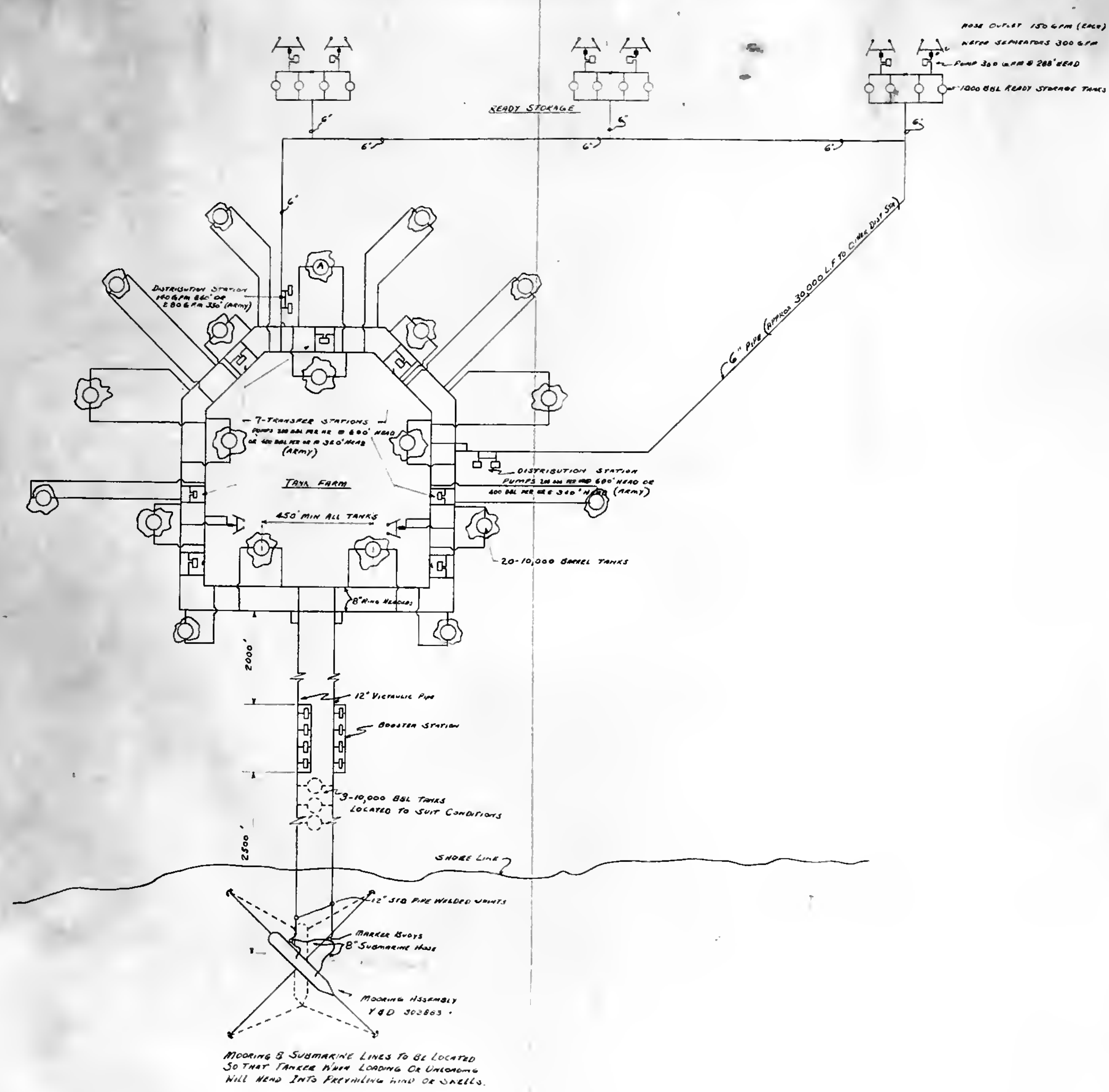
Y & D Drawing No. 398,902

W. E. NUMBER D-43-844

Scale 1" = 400' (Approx.)

APPENDIX, Figure 1

264



ARMY STK NO	NAVY ASSEMBLY NO	DESCRIPTION	QUAN.	DWG. NO.
[illegible]	5351	MOORING (60 FT. DEPTH OF WATER)	1	[illegible]
[illegible]	2202	SEA LOADING LINE, 12"	2	[illegible]
	2203	BOOSTER STA., & PUMP 12"	2	[illegible]
[illegible]	2205	TANK 10,000 BBL. 8"	60	[illegible]
[illegible]	2208	TRANSFER PUMP GASOLINE	7	[illegible]
[illegible]	2211	DISTRIBUTION STA. GASOLINE	2	398310
[illegible]	2212	READY STORAGE, GASOLINE	6	[illegible]
[illegible]	2213	SEPARATOR, WATER/GASOLINE	2	[illegible]
[illegible]	2214	RACK	2	[illegible]
[illegible]	2218	DISTRIBUTION PIPE 5000 FT/6"	6	[illegible]
	2022	TOOL KIT	6	

MISCL. MATERIAL

ITEM NO	DESCRIPTION	UNIT	ARMY STOCK NO	NAVY STOCK NO	QUAN.
Z-1	REDUCER: VICTAULIC TYPE STD WT.				
	G.B.E. 12"x6"	EA.	[illegible]	[illegible]	4
Z-2	COUPLING: VICTAULIC TYPE W/BOLTS,				
	NUTS & GASKETS 6"	EA.	[illegible]	[illegible]	4
Z-3	COUPLING: VICTAULIC TYPE W/BOLTS				
	NUTS & GASKETS 12"	EA.	[illegible]	[illegible]	4

NOTES

REFERENCE DRAWINGS

Y&D 398,900 TO 913 INCL.

APPROVED BY BUREAU OF ______

DATE ______ BY ______

FUNCTIONAL COMPONENT

5
4
3
2
1

Revision | Date

Prepared by CJM
Traced by WHJ
Checked by CJM-RR.
Supervisor CJM
Group Chief
Chief Draftsman
Des. Engr.
Proj. Mgr.
Design Mgr.
Sheet of

ASSEMBLY NO
TROP
NORTH

Scale 1"= 200'

W.P. NUMBER D-45-854

NAVY DEPARTMENT — BUREAU OF YARDS & DOCKS

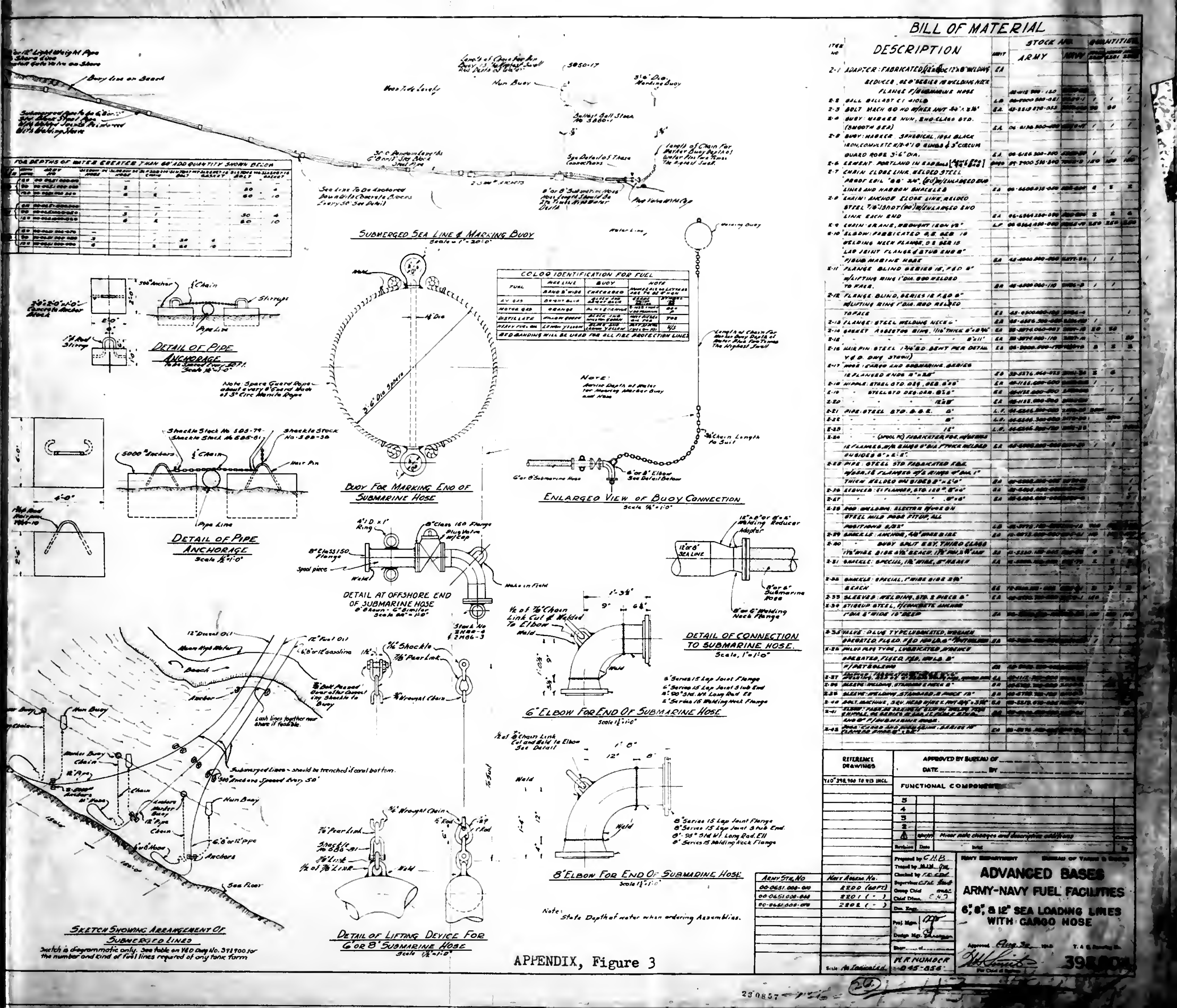
ADVANCED BASES
ARMY-NAVY FUEL FACILITIES
200,000 BBL COMPONENT GASOLINE TANK FARM

Approved Aug 30, 1945

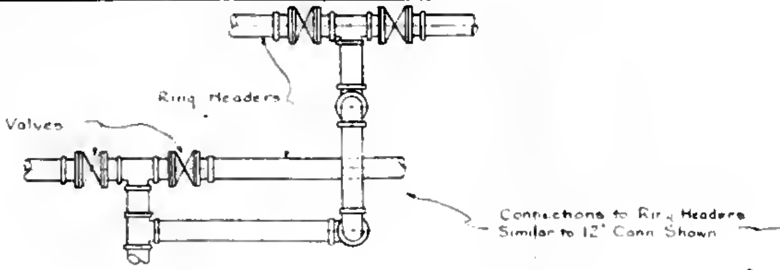
Per Chief of Bureau

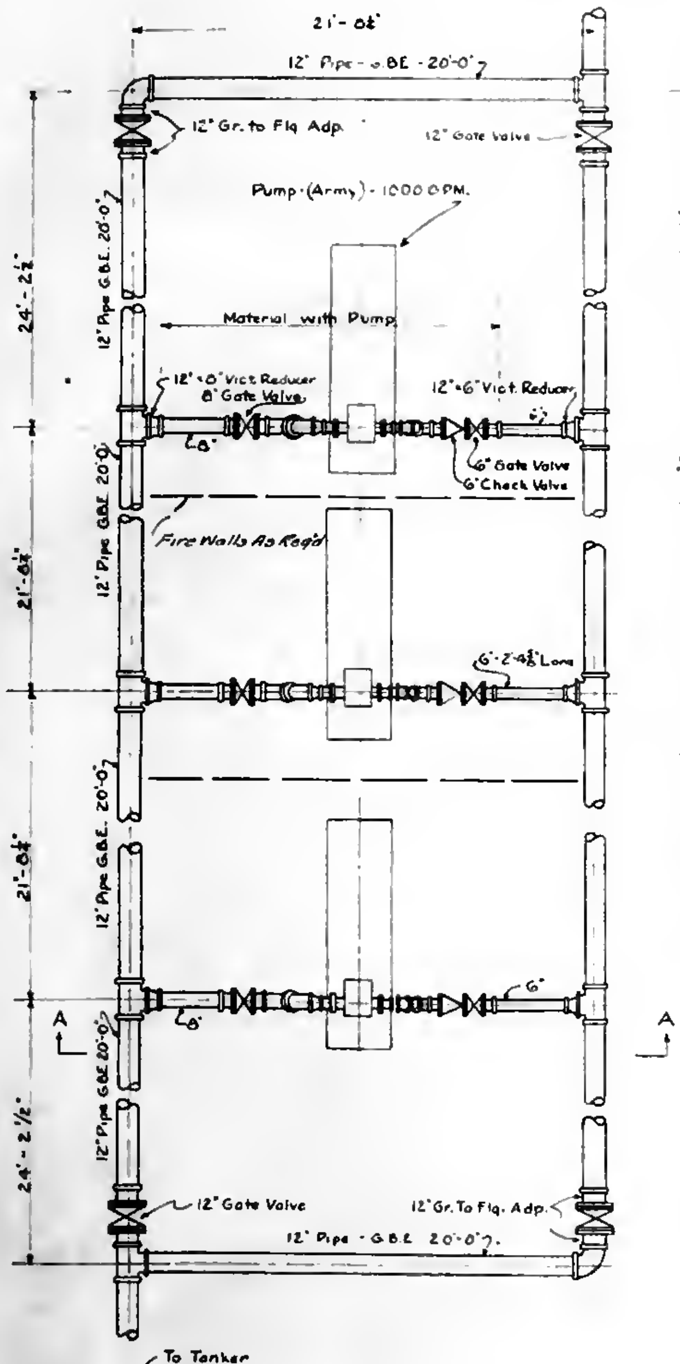
Y. & D. Drawing No. 398,901

APPENDIX, Figure 2

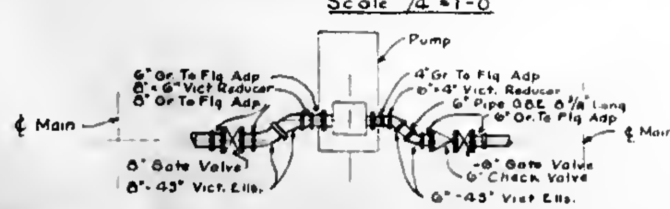


APPENDIX, Figure 3

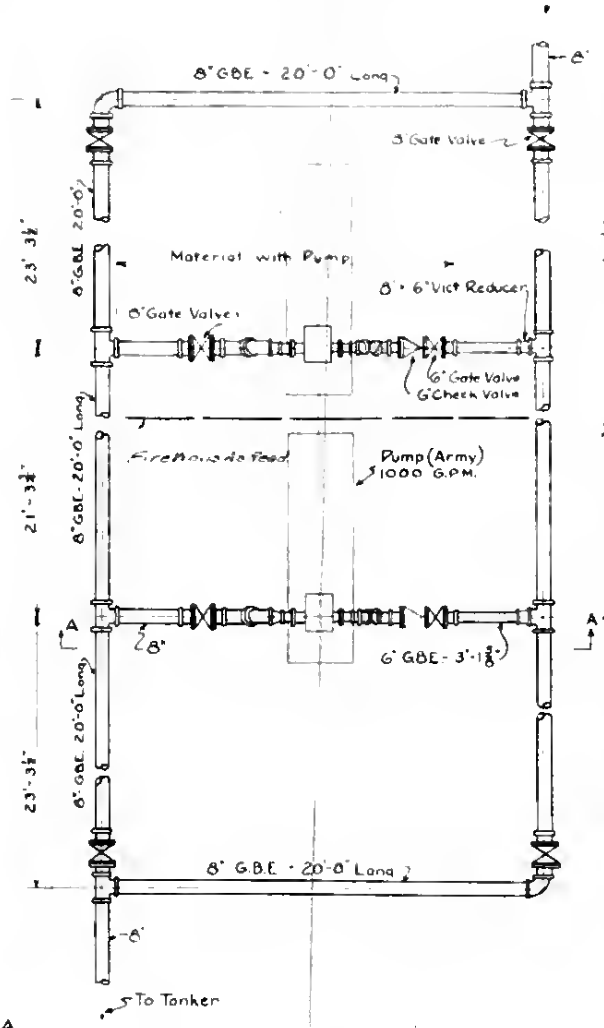




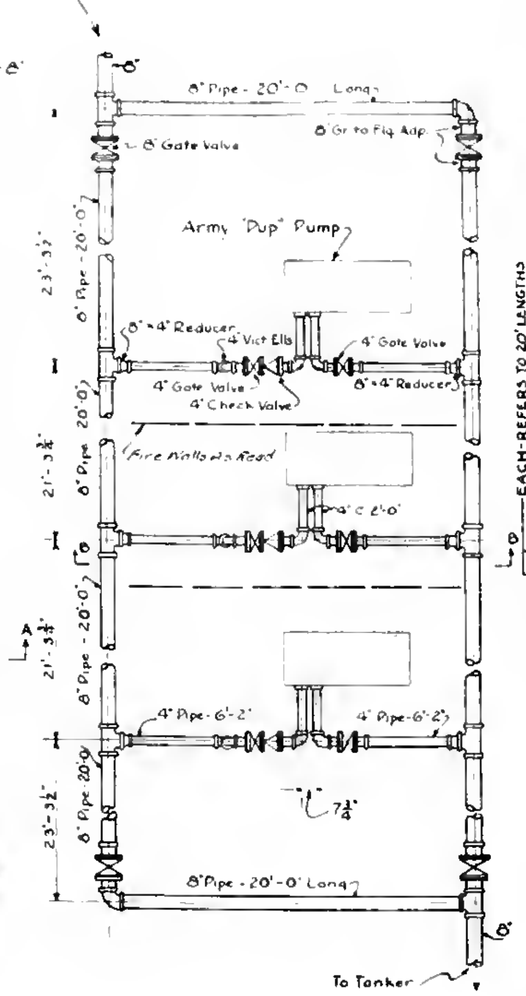
BOOSTER STATION (12" MAINS).
2 - 3 OR 4 - 1000 G.P.M. (ARMY PUMPS).
3000, 4500 OR 6000 BBL. PR. HR. GASOLINE.
2000, 3000 BBL. PR. HR. FUEL & DIESEL OIL.
Scale ¼"=1'-0"



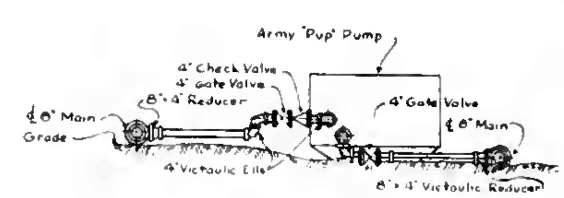
SECTION "AA"
Scale ⅛"=1'-0"



BOOSTER STATION (8" MAINS).
2-1000 G.P.M. ARMY PUMPS.
3000 BBL. PR. HR. GASOLINE.
Scale - ¼"=1'-0"



BOOSTER STATION (8" MAINS)
3 - ARMY "PUP" PUMPS.
1500 - BBL. PR. HR. GASOLINE.
Scale - ¼"=1'-0"



SECTION "B-B"
Scale ⅛"=1'-0"

ASSEMBLIES
2-1000 G.P.M. PUMPS F/GASOLINE W/8" PIPE - No. 2203
2-1000 G.P.M. PUMPS F/DIESEL OR FUEL OIL W/12" PIPE - No. 2204
3-1000 G.P.M. PUMPS F/DIESEL OR FUEL OIL W/12" PIPE - No. 2221
4-1000 G.P.M. PUMPS F/GASOLINE W/12" PIPE - No. 2223
3-ARMY "PUP" PUMPS W/8" PIPE - No. 2222

BILL OF MATERIAL

ITEM No.	DESCRIPTION	UNIT	STOCK NO. ARMY	STOCK NO. NAVY	QUANTITY ASSEMBLY NO. 2203	2204	2221	2222	2223	
2-1	ADAPTER: FABRICATED 4" STD PIPE 6" LONG OEG, OE. SERIES 15 SLIP ON WELDING FLANGE	EA.	45 1122 660 040	2H99-9				12		
2-2	GASKET: FOR VICTAUL COUPLING 12"	"	35 4510 500-120	2H67-42		50	50		50	
2-3	ADAPTER: FABRICATED 8" STD PIPE 6" LONG OEG, OE. SERIES 15 SLIP ON WELDING FLANGE	"	45 1122 660 080	2H99-27	12			16		
2-4	ADAPTER: FABRICATED 12" STD. PIPE 8" LONG OEG, OE SERIES 15 SLIP ON WELDING FLANGE	"	45-112.625-127	2H99-31		16	18		18	
2-5	BOLT: MACHINE SQ. HD. W/HEX NUT ⅝" × 3"	"	45 2219 060-030	7047-444				150		
2-6										
2-7	" " " " " " " ¾" × 5½"	"	45-2219.070 035	7047447	110			140		
2-8	" " " " " " " ⅞" × 3¾"	"	45-2219.080 037	7047448	–	220	220	–	220	
2-9										
2-10	COUPLING: M.I. SCR. STD. ¾"		45-2736.500-007	2H60-19	2	2	2	2	2	
2-11	COUPLING: VICT. TYPE W/BOLTS, NUTS & GASKETS 4"	"	45 2904.500-040	2H60-43				50		
2-12										
2-13	" " " " " " " 8"	"	45-2904.500-080	2H60-45	225			285		*
2-14	" " " " " " " 12"	"	45-2904.500-120	2H60-46	–	240	285	–	270	*
2-15	ELBOW: M.I. SCR. STD 90° ¾"		45 3716.930-007	2H77-43	4	2	4	4	4	
2-16										
2-17	" VICTAULIC - 45° 8"	"	45 4052.450-080	2H77-88	10			8		
2-18	" " " 12"	"	45 4052.450 126	2H77-89	–	10	10		10	
2-19	" " 90° 4"	"	45 4052-900 045	2H77-90		–	–	20	–	
2-20	" " " 8"	"	46 4052.900-086	2H77-92	8	–	–	8	–	
2-21	" " " 12"	"	45 4052 900 127	2H77-93	–	8	8		8	
2-22	GASKET ASBESTOS RING, 1/16 THICK, 4" × 6⅞"	"	55 3774 040-068	2H67-9				20		
2-23										
2-24	" " " " " 8" × 11"	"	33 3774-080-110	2H67-16	20			28		
2-25	" " " " " 12" × 16⅛"	"	33 3774-120-161	2H67-19	–	20	28	–	25	
2-26	NIPPLE: STEEL STD. ¾" × 2" SHORT	"	45 3750.007-020	2H62-26	12	12	12	12	12	
2-27	PIPE: STEEL T&C ¾"	L.F.	44-6246 700-007	2H72-10	42	42	42	42	42	
2-28	" " LIGHT WEIGHT, GBE 8"	EA.	44-8276.080-200	2H72-4	110	–	–	110	–	*
2-29	" " " " " 12"	EA.	44-8276.120-200	2H72-8	–	110	110	–	388	*
2-30	" " FABRICATED, " 6" × 2' - 4⅝"	EA.		2H74-33		2	3	–	4	
2-31	" " " " 6" × 3' - 1⅝"	"		2H74-34	2			–		
2-32										
2-33										
2-34	" " " " 4" × 2'-0"	"	45-5795.400-240	2H74-30	–	–	–	8	–	
2-35	" " " " 4" × 6'-2"	"		2H74-32	–			6	–	
2-36										
2-37	PUMP CENTRIFUGAL, GASOLINE - 3", W/4" VICTAULIC ADAPTERS, 200 BBL. PER HR. AT 680 HD. OR IN PARALLEL 400 BBL. PER HR. AT 340 HD.	"	11-4927-440.000	2H93-97				3		
2-38										
2-39	REDUCER, VICTAULIC TYPE, STD GBE 8" × 6"	"	45 6628 080-060	2H84-41	2					
2-40	" " " " " 12" × 6"	"		2H84-54		2	3		4	
2-41	" " " " " 12" × 8"	"	45 6628.120-080	2H84-42		2	3		4	
2-42	" " " " " 8" × 4"	"	45 6628.080-040	2H84-40				6		
2-43	TEE: VICTAULIC TYPE 8" × 8" × 8"	"	45 8084.500-086	2H75-150	10			12		
2-44	" " " 12" × 12" × 12"	"	45 8084.500-127	2H75-151		10	12		14	
2-45	UNION: G.J., M.I., STD. ¾"	"	45 8392.600-007	2H79-13	2	2	2	2	2	
2-46	VALVE: CHECK SWING FLNGD 125# ST., 200# OWG 4"	"	45 8835.500-040	2H88-12				3		
2-47										
2-48	" GATE FLANGED 125# ST., 200# OWG, 4"	"	45 8840 200-040	2H89-48				6		
2-49										
2-50	" " " " " " " 8"	"	45 8840.200-080	2H89-54	4			6		
2-51	" " " " " " " 12"	"	45 8840.200-120	2H89-59		6	8		8	
2-52	" " SCR. " " " " ¾"	"	45 8840.500-007	2H89-64	2	2	2	2	2	
2-53	GASKET FOR VITAULIC COUPLING 8"	"	35 4510 500-080	2H67-41	50			30		
2-54	NIPPLES: STEEL STANDARD OEG, OEB, 8" × 6"	"	45 1182.680-080	2H62-203	12			12		
2-55	" " " " " 12" × 8"	"	45-1182.600-900	2H62-204		12	12		12	
2-56										
2-57										
2-58										
2-59	PUMPING STATION: COMPLETE W/2 CENTRIFUGAL GASOLINE DRIVEN PUMPS, 1000 G.P.M. EACH AT 90 PSI AND MANIFOLD ASSEMBLY	"	11-8084-750-000	2H119-1	1	1	[illegible]		[illegible]	

*

STOCK NUMBERS	
Y&D	SNS
2H60-45	145-C-5068-150
2H60-46	145-C-5068-200
2H72-4	144-P-315-665
2H72-5	144-P-315-670

REFERENCE DRAWINGS
Y&D 398,900 TO 913 INCL.

NOTES
1. * For Each Two Assemblies 2221 Shipped.

FUNCTIONAL COMPONENT

Revision	Date	Brief	By
1	4-11-51	ITEMS 2-13,14,28&29 CHANGED IN QUANTITY, PIPE DESCRIPTION & UNIT	

ARMY STOCK NO.	NAVY ASSEMBLIES
00-0676.000-020	No. 2203
	No. 2204
	No. 2221
00-0676.000-010	No. 2222
00-0676.000-030	No. 2223

Scale AS NOTED

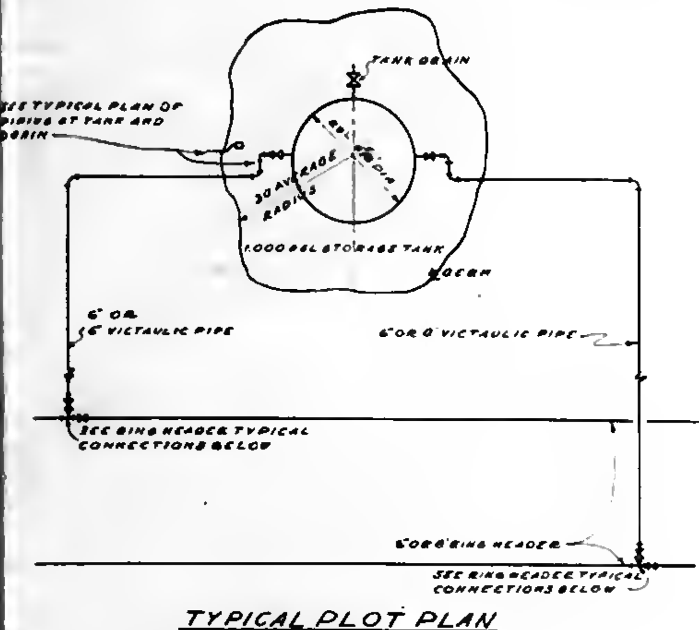
Prepared by C.J.M.
Traced by J.W.S.
Checked by C.J.M.-F.K.
Supervisor C.J.M.
Group Chief M.O.C.
Chief Dsgn. S.H.D.
Des. Engr.
Proj. Mgr.
Design Mgr.
Sheet of
W.R. NUMBER No. 046-884

NAVY DEPARTMENT BUREAU OF YARDS & DOCKS
ADVANCED BASES
ARMY - NAVY FUEL FACILITIES
BOOSTER STATIONS

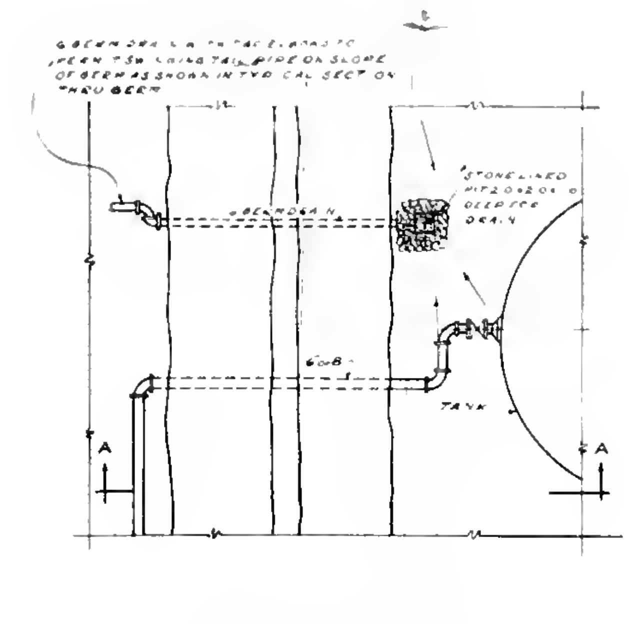
Approved Aug. 30, 1945
Y. & D. Drawing No. 398,905
For Chief of Bureau

337

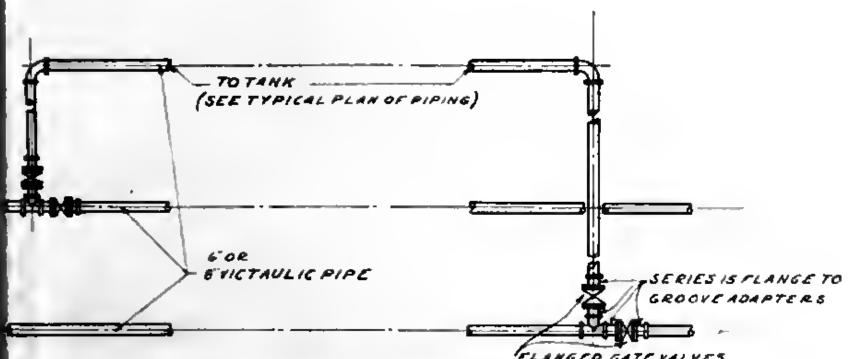
APPENDIX, Figure 4



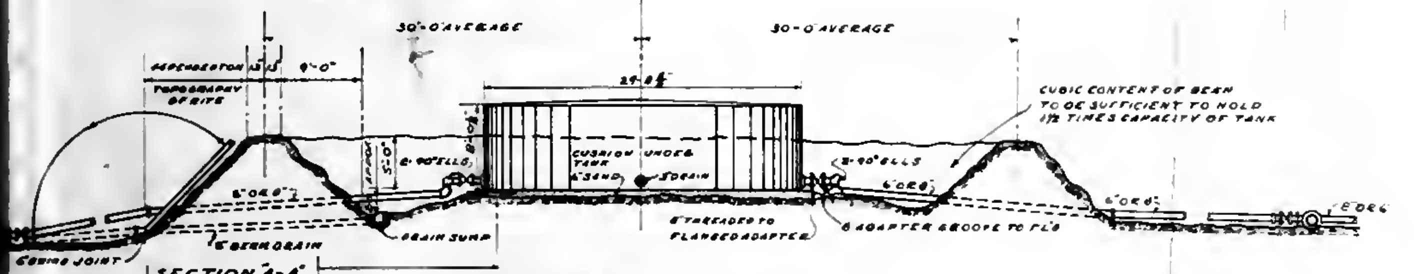
TYPICAL PLOT PLAN
TANK & PIPING
SCALE 1" = 30'-0"



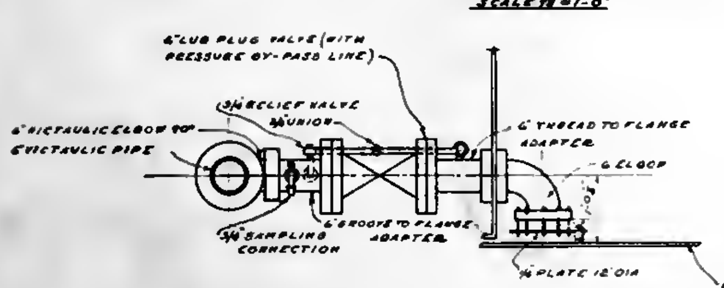
TYPICAL PLAN
PIPING TANK & DRAIN
SCALE 1/8" = 1'-0"



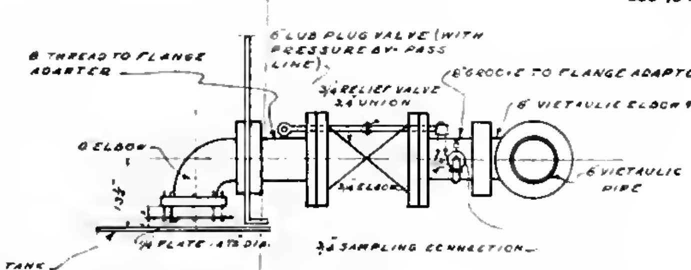
RING HEADER
TYPICAL CONNECTIONS
SCALE 1/8" = 1'-0"



TYPICAL SECTION THRU BERM
SCALE 1/8" = 1'-0"



TYPICAL 6" TANK CONNECTION
SCALE 3/4" = 1'-0"



TYPICAL 8" TANK CONNECTION
SCALE 3/4" = 1'-0"

STOCK NUMBERS	
Y&D	SNS
2H80-44	Y45-C-5068-125
2H80-45	Y45-C-5068-150
2H72-3	Y44-P-135-660
2H72-4	Y44-P-4315-665

BILL OF MATERIAL

ITEM NO	DESCRIPTION	UNIT	STOCK NO ARMY	STOCK NO NAVY	QUAN	
	ASSEMBLY NO. 2208 - 1000 BBL TANK W/8" PIPE					
2	ADAPTER FAB 8 STD PIPE 6 LG BEG OE					
	SERIES 15 SLIP ON WELDG FLG	EA	45 1128 600 060	2H99 27	12	
2-2	FAB 8 STD PIPE 6 LG BEV, OE					
	SERIES 15 SLIP ON WELDG FLG		45-1112 950-066	2H99-25	2	
2-3	BOLT MACH W/NUT 3/4 x 5	..	43-2188 070-080	7047-157	20	
2-4	.. SQ HD W/HEX NUT 3/4 x 3 1/2		43-2218 070-038	7047-447	160	
2-5	COUPLING MI SCR STD 3/4"	..	45 2736 300-007	2H80-17	6	
2-6	VICT TYPE W/BOLTS, NUTS & GASKETS 6"		45-2906 500-060	2H80-44	9	*
2-7	 8	..	45 2906 500-080	2H80-45	183	*
2-8	ELBOW VICT 90° 6"		45-4032 900-060	2H77-91	2	
2-9	.. CI FLGD STD 90° 8"		45-3576 900-080	2H77-270	2	
2-10	CI SCR STD 90° 2"	.	45-3632 900-020	2H77-8	1	
2-11	.. MI .. .. 90° 3/4"	..	45-3716 930-007	2H77-45	10	
2-12	.. VICT 90° 8	..	45-4032 900 086	2H77-92	12	
2-13	.. VICT 45° 8"	..	45-4032 450-086	2H77-88	4	
2-14	FLANGE C.I. SCR FLG 125# 8"	..	45-4360 000-135	2H81-26	2	
2-15	GASKET ASBESTOS RING 1/16" THICK 8 x 11"	..	33-3914 060-110	2H81-16	20	
2-16	.. FOR VICTAULIC COUPLING 8"	..	33-4310 500-080	2H87-41	40	
2-17	NIPPLE STEEL STD 3/4 x 2" (SHORT)	..	45-5730 007-020	2H82-24	30	
2-18	.. .. .. 2 x 2" (CLOSE)	..	45-5780 020-020	2H82-55	2	
2-19	.. .. BEG. BEB 8 x 6"	..	45-1128 600-800	2H82-203	12	
2-20	PIPE STEEL, LIGHT WEIGHT, GBE. 8"	.	44-8376 080-300	2H72-4	80	*
2-21	.. T&C 3/4"	L.F.	44-6246 700-007	2H12-10	84	
2-22	.. LIGHT WEIGHT, GBE 6"	EA		2H72-3	3	*
2-23	PLATE 1/4 x 14 1/2 & DRILLED FOR 8" STD 125#					
	FLANGE BOLTING	.	45-3980 030-145	2H86-46	2	
2-24	TANK GASOLINE, BOLTED. 1000 BBL. 42000 GAL.					
	COMPLETE W/ACCESSORIES, LOW TYPE.	..	58-8690 710-010	2H71-37	1	
2-25	TEE M.I. VICTAULIC 8 x 8 x 8"	..	45-8084 500-080	2H78-150	2	
2-26	UNION G I M.I. STD. 3/4"	..	45-8332 600 007	2H79-12	4	
2-27	VALVE: GATE FL'GD, 125# STEAM, 200# OWG 8"	..	45-8840 300-080	2H89-54	6	
2-28	SCR. .. .. 3/4"	..	45-8840 300-007	2H89-26	2	
2-29	RELIEF, GASOLINE SCR'D SET @ 200# 3/4"					
	FEMALE INLET & 3/4" FEMALE SIDE					
	OUTLET.	..	45-8817 075-275	2H89-272	2	
	ASSEMBLY NO. 2207 - 1000 BBL TANK - W/6" PIPE					
2-1	ADAPTER: FAB 6" STD PIPE 6" LONG BEG					
	OE SERIES 15 WELDING FL'G	EA	45-1128 660-060	2H99-53	12	
2-2	.. .. 6" L'G BEV, OE SERIES 15 SLIP ON					
	WELDING FLANGE.	..	45-1112 950-066	2H99-25	2	
2-3	BOLT: MACH. W/NUT 3/4" x 5"	..	43-2188 070-080	7047-157	20	
2-4	.. .. SQ HD. W/HEX NUT 3/4" x 3 1/2"	..	43-2218 070-033	7047-446	160	
2-5	COUPLING: M.I. SCR. STD. 3/4"	..	45-2736 300-007	2H80-17	6	
2-6	.. VICT. TYPE W/BOLTS, NUTS & GASKETS 6"	.	45-2906 500-060	2H80-44	183	*
2-7	ELBOW: C.I. FLANGED STD 90° 6"	..	45-3576 900-060	2H77-67	2	
2-8	.. .. SCR'D .. 90° 2"	..	45-3632 900-020	2H77-8	1	
2-9	.. M.I. .. .. 90° 3/4"	..	45-3716 930-007	2H77-45	10	
2-10	.. VICT. 45° 6"	..	45-4032 450-066	2H77-81	4	
2-11	.. .. 90° 6"	..	45-4032 900-066	2H77-91	12	
2-12	FLANGE: C.I. SCR'D FLG 125# 6"	..	45-4360 060-110	2H86-25	2	
2-13	GASKET: ASBESTOS RING 1/16" THICK 6" x 8 3/4"	..	33-3876 060-087	2H87-12	20	
2-14	.. FOR 6" VICT. COUP.	..	33-4310 500-660	2H87-40	40	
2-15	NIPPLE STEEL STD 3/4" x 2" (SHORT)		45-5700 007-020	2H82-24	38	
2-16	.. .. .. 2" x 2" (CLOSE)	..	45-5780 020-020	2H82-55	2	
2-17	.. .. .. BEG. B.E.B 6" x 6"	..	45-1128 600-600	2H82-202	12	
2-18	PIPE: STEEL. LIGHT WEIGHT, GBE. 6"	..	44-8276 060-200	2H72-3	80	*
2-19	.. .. STD T&C 3/4"	L.F.	44-6246 700-007	2H12-10	84	
2-20	PLATE: 1/4 x 12" & DRILLED FOR 6" STD 125# FLG BOLTG	EA.	45-5980 030-120	2H86-47	2	
2-21	TANK GASOLINE, BOLTED STEEL 1000 BBL.					
	COMP. W/ACCESSORIES (42,000 GAL) LOW TYPE	..	58-8690 710-010	2H71-37	1	
2-22	TEE: VICT. 6" x 6" x 6	..	45-8084 500-066	2H15-49	2	
2-23	UNION: G.J. M.I. STD. 3/4"	..	45-8332 600-007	2H79-13	4	
2-24	VALVE: GATE FL'GD 125# STEAM 200# OW.G 6"	..	45-8840 300-060	2H89-50	6	
2-25	.. .. SCR .. .. 3/4"	..	45-8840 300-007	2H89-46	2	
2-26	.. RELIEF GASOLINE SCR SET AT 200#					
	3/4" FEMALE INLET & 3/4" SIDE OUTLET.	..	45-8817 075-273	2H89-272	2	

EACH REFERS TO 20' LENGTHS (items 2-20, 2-22, Assembly 2208)

SEE NOTE BELOW (item 2-29)

EACH REFERS TO 20' LENGTHS (item 2-18, Assembly 2207)

ARMY EQUIVALENT TO ITEMS { 2-29: ASSEMBLY 2208; 2-26: 2207 }
VALVE IRON, CAST, BRONZE VALVE BODY, PRESSURE RELIEF, FOR GASOLINE (537-2402) 75 TO 100 LB PRESS. FACTORY SET AT 85 LBS., 3/4" FITTINGS, HANLON WATERS No 273 OR EQUAL.
STOCK No 45-8817.075-273
300 TO 400 LBS, SET AT 350 LBS 45-8817 300-273

REFERENCE DRAWINGS

Y&D 398900 TO 913 INCL

FUNCTIONAL COMPONENT

1	4-11-51	CHANGED ITEMS 2-6, 7, 20 & 22 ASSY 2208 ITEMS 2-6 & 18 ASSY 2207	CORNELL
Revision	Date	Item	By

ARMY STOCK No	NAVY ASSEMBLY No.
00 0890.000-020	2207
00 0890.000-030	2208

Prepared by ...
Traced by ...
Checked by ...
Supervisor ...
Group Chief ...
Chief Draftsman ...
Des. Engr
Proj. Mgr.
Design Mgr.
Sheet ... of ...
Scale As Indicated
W. R. NUMBER 045:854

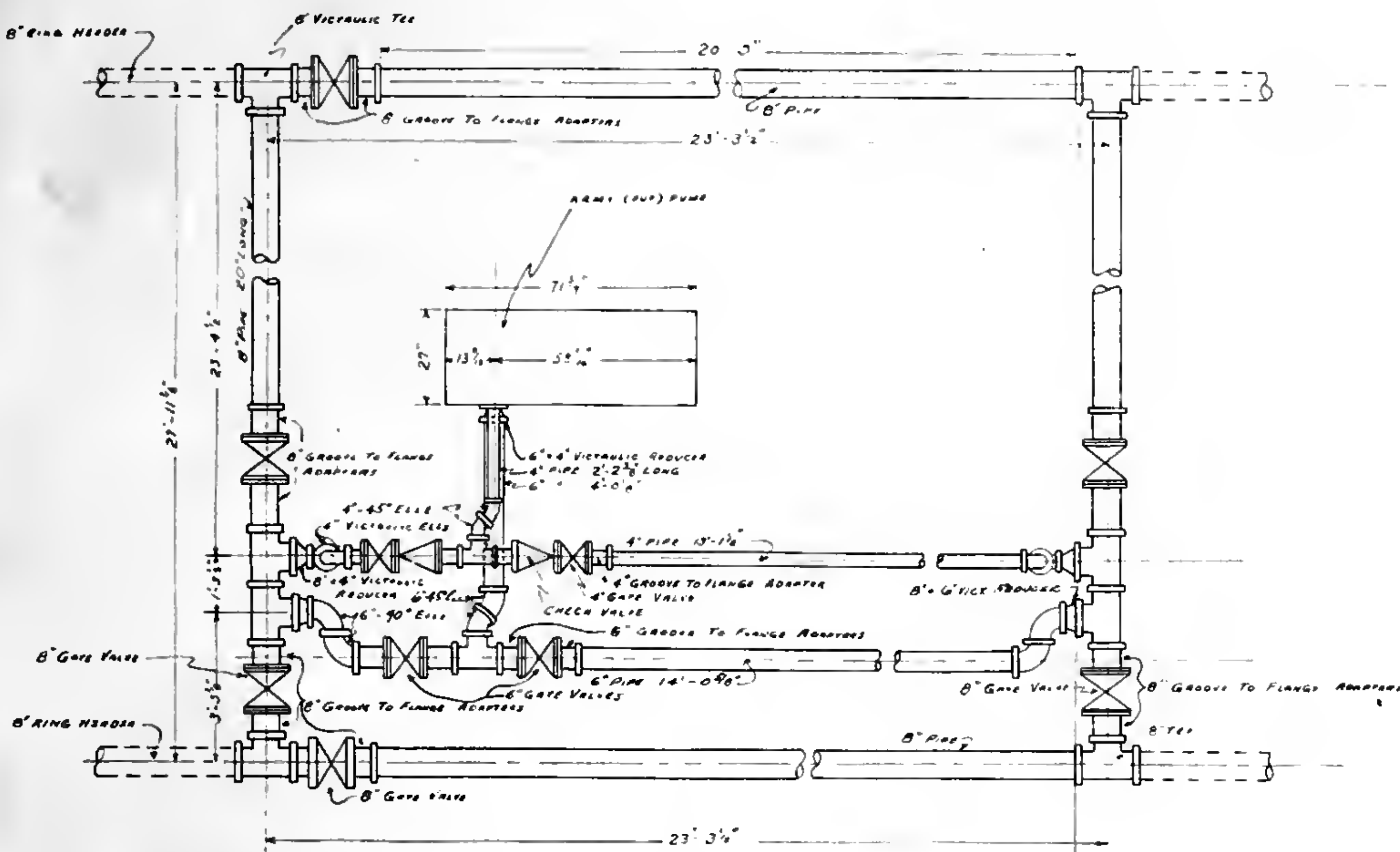
NAVY DEPARTMENT BUREAU OF YARDS & DOCKS

ADVANCED BASES
ARMY-NAVY FUEL FACILITIES
TANK 1000 BBL

Approved Aug. 3, 1950
For Chief of Bureau
Y & D. Drawing No. 398,907

APPENDIX, Figure 5

234557



TRANSFER PUMP GASOLINE WITH 8" PIPE

ASSEMBLY NO 2209

BILL OF MATERIAL

ITEM NO.	DESCRIPTION	UNIT	STOCK NO. ARMY	STOCK NO. NAVY	QUAN.	
2-1	ADAPTER FAB. 4" STD PIPE 6" LONG OEG, OE SERIES 15					
	SLIP ON WELDING FLANGE	EA.	[illegible]	2H99-9	5	
2-2	ADAPTER: FAB 6" STD. PIPE 6" LONG OEG. OE SERIES					
	15 SLIP ON WELDING FLANGE	EA	[illegible]	2H99-53	5	
2-3	ADAPTER FAB 8" STD PIPE 6" LONG OEG, OE SERIES					
	15 SLIP ON WELDING FLANGE	EA	[illegible]	2H99-27	12	
2-4	BOLTS- MACH SQ HD W/HEX NUTS ⅝ × 3"	"	[illegible]	7047-444	65	
2-5	" " " " " " ¾ × 3¼"	"	[illegible]	7047-446	50	
2-6	" " " " " " ¾ × 3½"	"	[illegible]	7047-447	115	
2-7	COUPLING VICT TYPE W/BOLTS, NUTS & GSKTS. 4"	"	[illegible]	2H80-43	15	
2-8	" " " " " " " 6"	"	[illegible]	2H80-44	15	
2-9	" " " " " " " 8"	"	[illegible]	2H80-45	40	*
2-10	ELBOW- VICTAULIC 90° 6"	"	[illegible]	2H77-31	4	
2-11	" " " 4"	"	[illegible]	2H77-30	4	
2-12	" " 45° 6"	"	[illegible]	2H77-87	2	
2-13	" " " 4"	"	[illegible]	2H77-86	2	
2-14	GASKETS. ASBESTOS RING 1/16" THICK, 4" × 6⅛"	"	[illegible]	2H87-9	10	
2-15	" " " " " 6" × 8¼"	"	[illegible]	2H87-13	7	
2-16	" " " " " 8" × 11"	"	[illegible]	2H87-16	16	
2-17						
2-18	PIPE STEEL - LIGHT WEIGHT, GBE, 8"	"	[illegible]	2H78-4	4	*
2-19	" " STANDARD GBE, 6" × 14'-0⅝"	"		2H74-59	1	
2-20	" " " " 6" × 4'-0⅛"	"		2H74-58	1	
2-21	" " " " 4" × 13'-1½"	"		2H74-56	1	
2-22	" " " " 4" × 2'-2⅜"	"		2H74-55	1	
2-23		"				
2-24	PUMP: CENTRIFUGAL, ENGINE DRIVEN 3"					
	W/4" VICTAULIC ADAPTERS 200 BBL.					
	PER HOUR AT 680 FT HD. OR IN					
	PARALLEL 400 BBL. PER HR. AT 340 FT					
		"	11-4927-440[illegible]	2H33-39	1	
2-25	REDUCER: VICTAULIC TYPE STD WT GBE, 8" × 6"	"	[illegible]	2H84-41	2	
2-26	" " " " " " 8" × 4"	"	[illegible]	2H84-40	2	
2-27	" " " " " " 6" × 4"	"	[illegible]	2H84-39	1	
2-28	TEE: VICTAULIC 8" × 8" × 8"	"	[illegible]	2H75-150	8	
2-29	" " 6" × 6" × 6"	"	[illegible]	2H75-149	1	
2-30	" " 4" × 4" × 4"	"	[illegible]	2H75-148	1	
2-31	VALVE: GATE FLANGED 125# ST. 200# OWG 4"	"	[illegible]	2H89-46	2	
2-32	" " " " " " " 6"	"	[illegible]	2H89-50	2	
2-33	" " " " " " " 8"	"	[illegible]	2H89-54	6	
2-34	VALVE: CHECK SWING FLANGED 125# ST. 200# OWG 4"	"	[illegible]	2H89-12	2	

EACH-REFERS TO 20' LENGTHS

NOTES

*

STOCK NUMBERS	
Y&D	SNS
2H80-45	Y45-C3060-150
2H78-4	Y44-P135-665

REFERENCE DRAWINGS

Y/D 398,908 TO 913 INCL

FUNCTIONAL COMPONENT

Revision	Date	Brief	By
1	4-11-51	CHANGED ITEM 2-18	[illegible]

ARMY STOCK NO 00-0673.000-020

NAVY ASSEMBLY NO. 2209

Prepared by C.S.M.
Traced by [illegible] JK
Checked by C.S.M.-F.A.
Supervisor C.S.M. [illegible]
Group Chief [illegible]
Chief Dftsm
Des. Engr
Proj. Mgr. [illegible]
Design Mgr. [illegible]
Sheet of
Scale
W R NUMBER D45-884

NAVY DEPARTMENT BUREAU OF YARDS & DOCKS

ADVANCED BASES
ARMY-NAVY FUEL FACILITIES

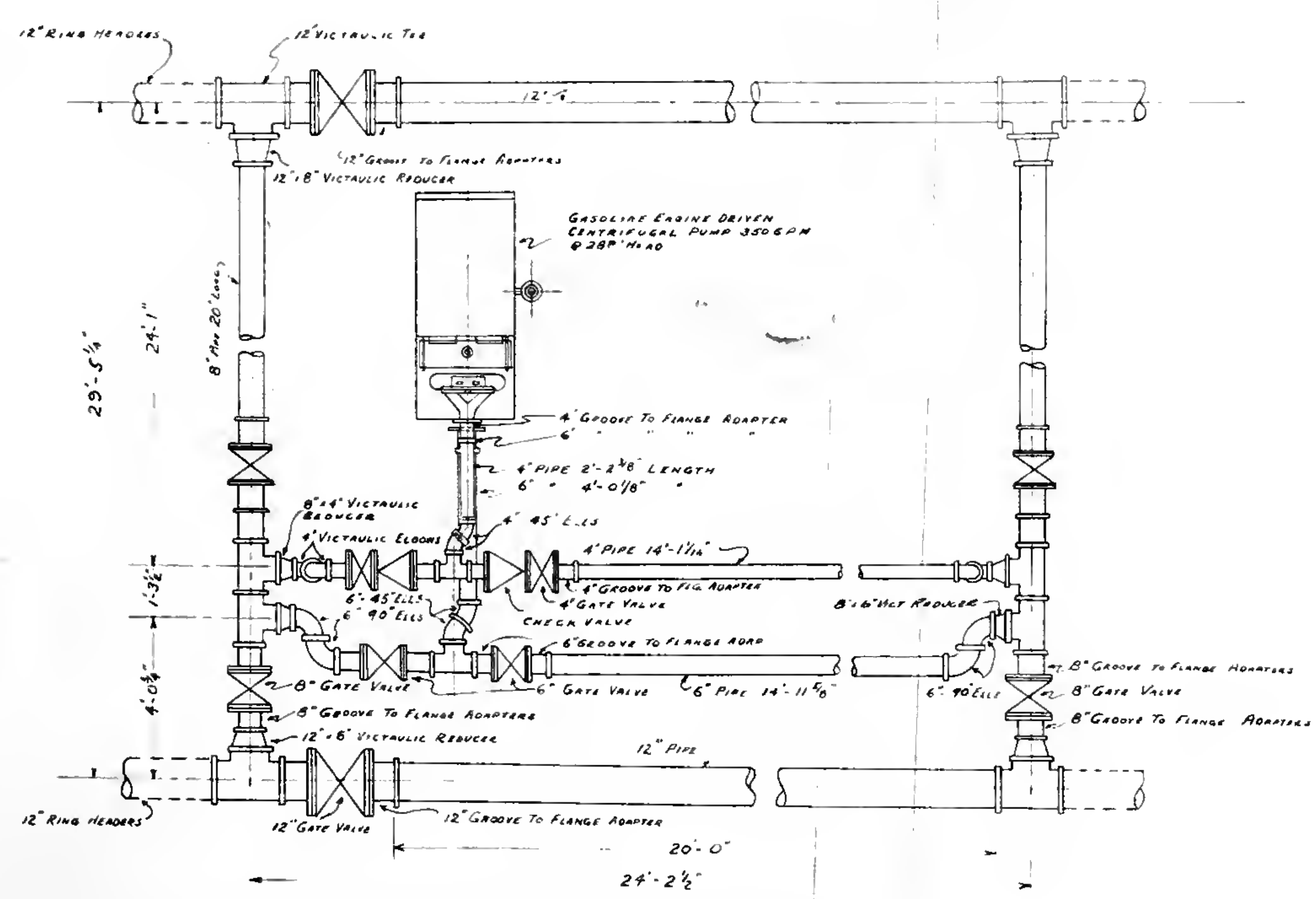
TRANSFER PUMP-GASOLINE WITH 8" PIPE

Aug. 30, 1945 Y & D. Drawing No. 398,908

For Chief of Bureau

340

APPENDIX, Figure 6



TRANSFER PUMP FUEL AND DIESEL OIL WITH 12" PIPE

ASSEMBLY NO. 2210

*

STOCK NUMBERS	
Y&D	SNS
2N80-45	Y45-C-5068-150
2N80-46	Y45-C-5068-200
2N72-4	Y44-P-1315-665
2N72-5	Y44-P-1315-670

BILL OF MATERIAL

ITEM NO	DESCRIPTION	UNIT	STOCK NO ARMY	STOCK NO NAVY	QUAN.
2-1	ADAPTER. FABRICATED 4", STD PIPE 6" LONG OEG, OE SERIES IS SLIP ON WELDING FLANGE	EA	49-1121.640-040	2N99-9	5
2-2	ADAPTER FABRICATED 6" STD PIPE 6" LONG OEG, OE SERIES IS SLIP ON WELDING FLANGE	EA	45-1121.660-060	2N99-83	5
2-3	ADAPTER FABRICATED 8" STD PIPE 6" LONG OEG, OE SERIES IS SLIP ON WELDING FLANGE	EA	44-1121.460-080	2N99-87	8
2-4	ADAPTER FABRICATED 12" STD PIPE 6" LONG OEG, OE SERIES IS SLIP ON WELDING FLANGE	EA	49-1121.660-120	2N99-31	4
2-5	BOLTS MACH SQ HD W/HEX NUTS ⅝" x 3"	"	45-2219.250-060	7047-444	65
2-6	" " " " " ¾" x 3¼"	"	45-2218.010-032	7047-446	50
2-7	" " " " " ¾" x 3½"	"	45-2212.010-035	7047-447	75
2-8	" " " " " ⅞" x 3¾"	"	45-2219.044-037	7047-448	66
2-9	COUPLING VICT TYPE W/BOLTS, NUTS & GSKTS 4"	"	45-1986.900-040	2N80-43	16
2-10	" " " " " " " 6"	"	45-1804.400-060	2N80-44	16
2-11	" " " " " " " 8"	"	44-1904.900-080	2N80-45	40
2-12	" " " " " " " 12"	"	44-2244.500-120	2N80-42	20
2-13	ELBOW VICTAULIC 90° 6"	"	45-4052.900-060	2N77-31	4
2-14	" " 90° 4"	"	45-4052.900-040	2N77-30	4
2-15	" " 45° 6"	"	45-4092.084-060	2N77-87	2
2-16	" " 45° 4"	"	45-4082.459-040	2N77-86	2
2-17	GASKET ASBESTOS RING ⅟16 THICK 4" x 6⅞"	"	33-8874.040-068	2N87-9	10
2-18	" " " " 6" x 8¾"	"	33-8874.060-087	2N87-13	7
2-19	" " " " 8" x 11"	"	33-3974.080-110	2N87-16	40
2-20	" " " " 12" x 16⅛"	"	33-8874.120-161	2N87-19	6
2-21					
2-22	PIPE STD, LIGHT WEIGHT G.O.E. 8"	"	44-8276.080-200	2N72-4	2
2-23	" " " " " " 12"	"	44-8276.120-200	2N72-5	2
2-24	STANDARD GOE; 4" x 2'-2⅞"	"		2N74-55	1
2-25	" " " 4" x 14'-1⅟16"	"		2N74-57	1
2-26	" " " 6" x 4'-0⅛"	"		2N74-58	1
2-27	" " " 6" x 14'-11⅝"	"		2N74-60	1
2-28	PUMP CENTRIFUGAL, ENGINE DRIVEN 4" DISC 6" SUCTION 350 GPM AT 288 FT HD.	EA		2N93-18	1
2-29	REDUCER. VICTAULIC TYPE STD WT GOE 12" x 8"	"	45-6628.120-080	2N84-42	4
2-30	" " " " " " 8" x 6"	"	45-6628.080-060	2N84-41	2
2-31	" " " " " " 8" x 4"	"	45-6628.080-040	2N84-40	2
2-32	" " " " " " 6" x 4"	"	45-6628.060-040	2N84-38	1
2-33	TEE: VICTAULIC 12" x 12" x 12"	"	45-8084.300-127	2N75-151	4
2-34	" " 8" x 8" x 8"	"	45-8084.900-080	2N75-150	4
2-35	" " 6" x 6" x 6"	"	45-8084.900-066	2N75-149	1
2-36	" " 4" x 4" x 4"	"	45-8084.900-045	2N75-148	1
2-37	VALVE: GATE FLANGED 125# ST, 200# OWG, 4"	"	45-8840.200-040	2N83-46	2
2-38	" " " " " " " 6"	"	45-8840.200-060	2N83-50	2
2-39	" " " " " " " 8"	"	45-8840.200-080	2N83-54	4
2-40	" " " " " " " 12"	"	45-8840.200-120	2N83-59	2
2-41	VALVE: CHECK SWING FLANGED 125# ST. 200# OWG, 4"	"	45-8636.000-040	2N83-18	2

EACH REFERS TO 20' LENGTHS (items 2-22, 2-23) * *

* *

NOTES

REFERENCE DRAWINGS

Y&D 898 960 TO 913 INCL

FUNCTIONAL COMPONENT

Revision	Date	Brief	By
1	4-11-51	CHANGED ITEMS 2-22 & 2-23	

Prepared by C.J.M.
Traced by
Checked by C.J.M.-F.R.
Supervisor C.J.M.
Group Chief
Chief Dftsm. CHD
Des. Engr.
Proj. Mgr.
Design Mgr.
Sheet of

NAVY ASSEMBLY No. 2210

Scale AS INDICATED

W.R. NUMBER. 045-854

NAVY DEPARTMENT BUREAU OF YARDS & DOCKS

ADVANCED BASES

ARMY-NAVY FUEL FACILITIES

TRANSFER PUMP-FUEL & DIESEL OIL WITH 12" PIPE

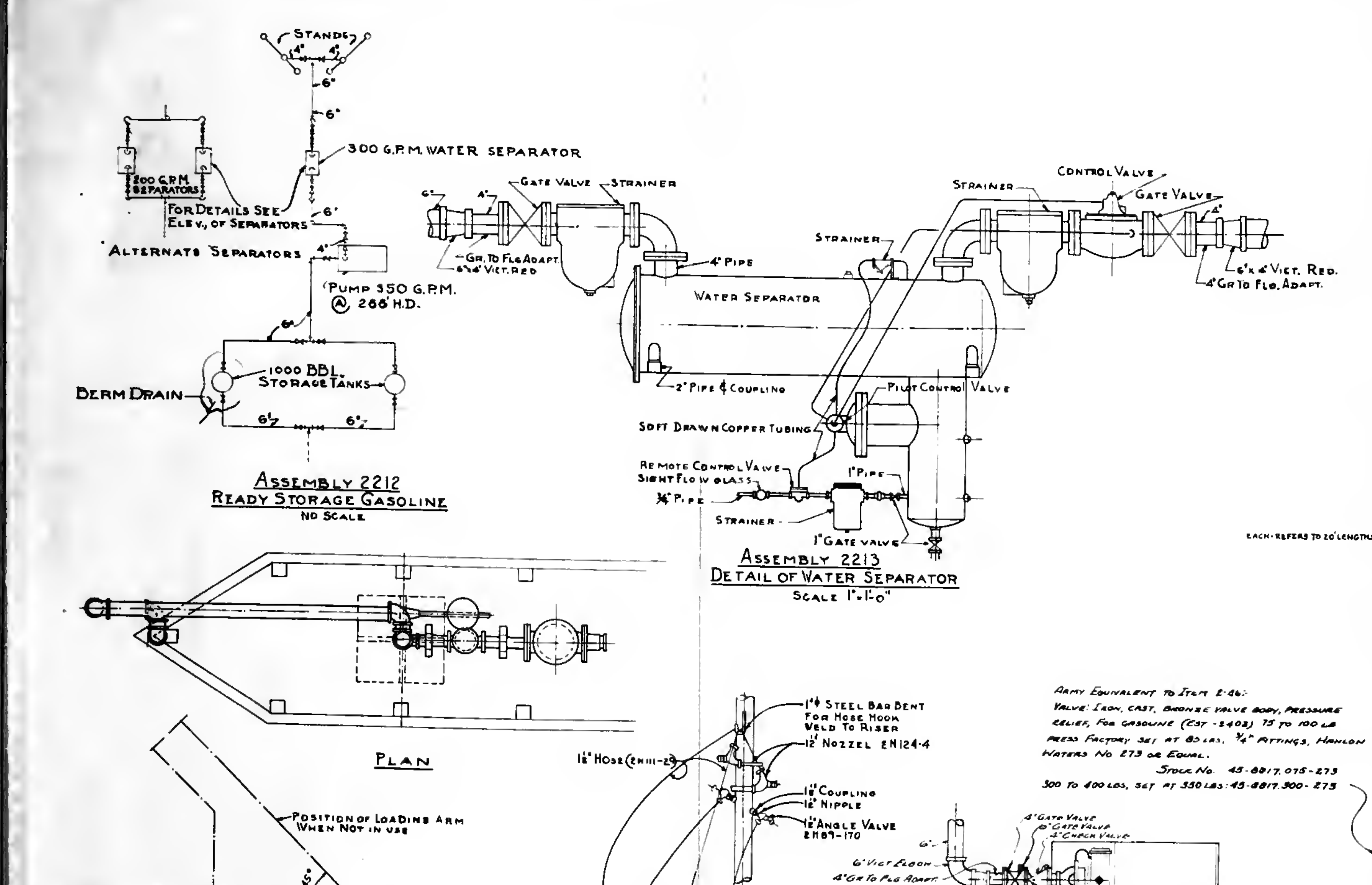
Approved Aug 30 1945

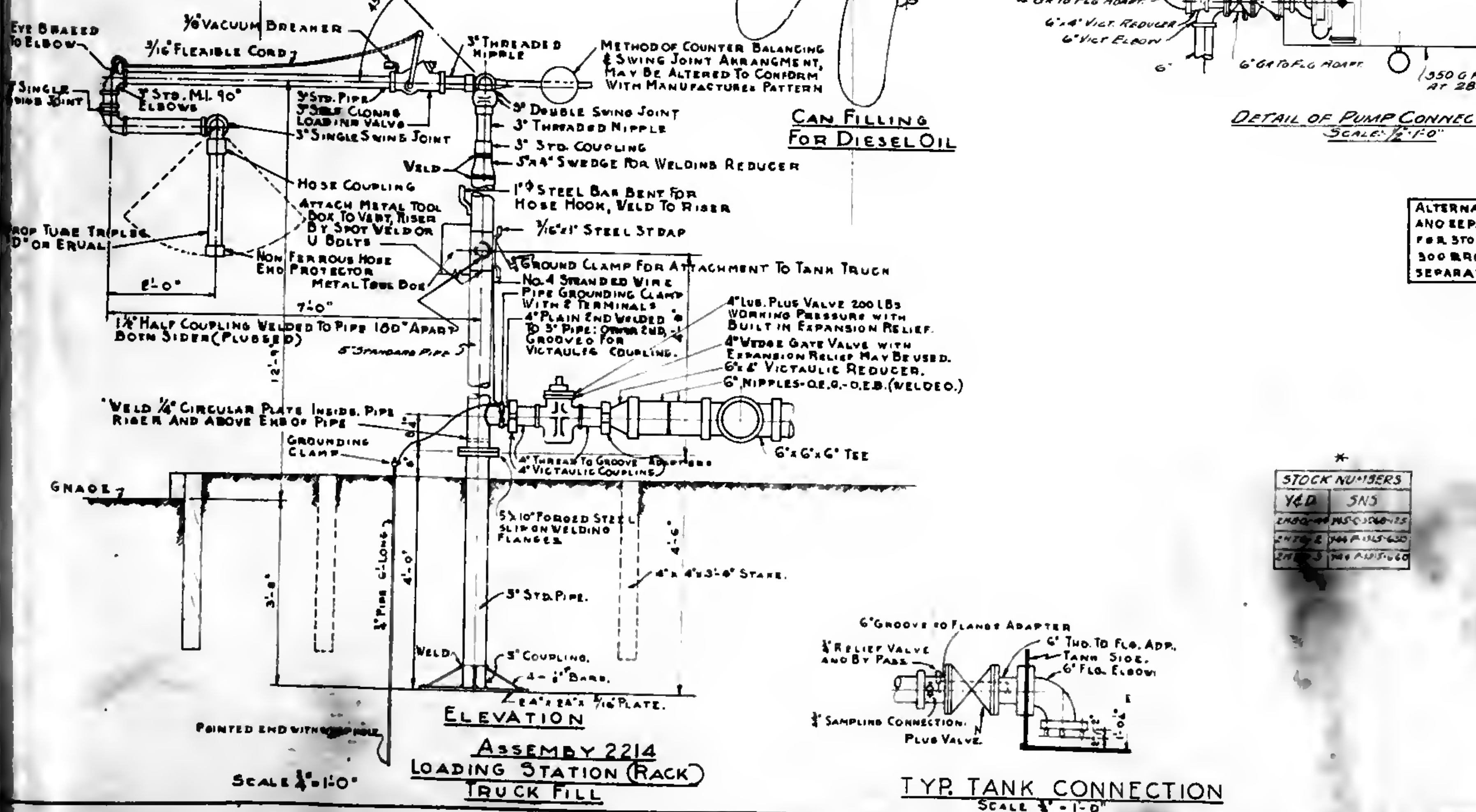
For Chief of Bureau

Y. & D. Drawing No. 398,909

341

APPENDIX, Figure 7





ALTERNATE LIST OF MATERIAL AND SEPARATOR IS SUBSTITUTED FOR STOCK LIST NO 2H153-4 300 G.P.M. WATER/GASOLINE SEPARATOR

STOCK NUMBERS	
Y&D	SNS
2H80-[illegible]	[illegible]
2H70-2	[illegible]
2H[illegible]-3	[illegible]

MATERIAL LIST

ITEM NO	DESCRIPTION	UNIT	STOCK NO. ARMY	NAVY / QUANTITIES
2-1	ADAPT: FAB 6" PIPE 6" LG. O.E.T.O.E. SERIES 15 FLG.	EA	45-015.[illegible]-066	[illegible]
2-2	" " 4" " 6" " O.E.G. " " " "	"	40-1122.[illegible]-060	[illegible]
2-3	" " 6" " 6" " " " " " "	"	45-1122.640-060	[illegible] 2
2-4	BOLTS: MACH. SQ.HD. W/HEX NUTS 3/8" x 3"	"	43-1619.060-000	[illegible]
2-5	" " " " " 3/4" x 3¼"	"	43-1119.070-085	[illegible] 20
2-6				
2-7	" " " W/NUTS 3/4" x 8"	"	43-[illegible]-070-080	[illegible]
2-8	COUPLINGS: M.I. SCR. STD. 3/4"	"	43-2106.300-007	[illegible] 18
2-9	" VICT. TYPE W/BOLTS, NUTS & GASKETS 4"	"	43-2904.[illegible]	[illegible] 2 2
2-10	" " " " " " 6"	"	43-2904.[illegible]	[illegible] 20 20 20
2-11	" M.I. SCR. STD. 1½"	"	43-2106.[illegible]-018	[illegible] 4
2-12	ELBOW: M.I. SCR. STD. 90° 3/4"	"	45-3710.[illegible]	[illegible]
2-13	" C.I. " " 90° 2"	"	45-6632.[illegible]	[illegible]
2-14	" C.I. FLGD. " 90° 4"	"	45-[illegible]	[illegible]
2-15	" C.I. " " 90° 6"	"	45-6576.[illegible]-050	[illegible]
2-16	"			
2-17	" VICTAULIC 90° 6"	"	45-4085.[illegible]	[illegible]
2-18				
2-19	" " 45° 6"	"	45-4082.[illegible]	[illegible]
2-20	FLANGE: C.I. SCR. 125# STD. F&D 8"	"	46-4560.[illegible]-110	[illegible] 4
2-21	NIPPLES: O.E.G. O.E.B. 6" x 6"	"	47-1183.[illegible]-000	[illegible] 18
2-22	GASKET: ASBESTOS RING 1/16" THICK [illegible]	"	33-3074.440-068	[illegible]
2-23	" " " " " [illegible]	"	33-3374.060-087	[illegible] 20
2-24	" VICTAULIC COUPLING 6"	"	[illegible]-4310.300-450	[illegible] 20
2-25	HOSE: GASOLINE, MALE & SWIVEL FEMALE	"		
	IPT. COUPLINGS - 1½" x 16' LONG (ARMY 25')	"	[illegible]	[illegible]
2-26	NIPPLES: STL. STD. 1½" x 2"	"	43-5750.001-[illegible]	[illegible]
2-27	" " " 1½" x 2½" (SHORT)	"	48-5750.019-025	[illegible]
2-28	" " " 2" x 2"	"	45-5750.[illegible]	[illegible]
2-29	NOZZLE: GASOLINE W/1½" RIGID TUBE 1½"	"	45-5960.[illegible]-120	[illegible]
2-30	PIPE: STEEL, T&C - ¾"	LF	[illegible]-6146.100-[illegible]	[illegible]
2-31	REDUCER: VICT. TYPE STD. WT. G.B.E. 8" x 6"	EA	45-6618.[illegible]	[illegible]
2-32	PIPE: STEEL, LIGHT WT. G.B.E. 6"	"	[illegible]	[illegible]
2-33	PLATE: ¾" x 12" & DRILLED FOR 6" [illegible] FLG.	"	46-3900.[illegible]	[illegible]
2-34	PUMP: CENTRIFUGAL, ENGINE DRIVEN			
	350 G.P.M. @ 288' HD. 4" DISCHARGE 6"			
	SUCTION	"		
2-35	RACK: TRUCK LOADING & CAN FILLING	"	[illegible]-0955.[illegible]	[illegible]
2-36	LOADING STATION: TRUCK FILL 4" [illegible]			
	SINGLE STAND, COMPLETE W/VALVES	"	45-[illegible]	[illegible]
2-37	SEPARATOR: GASOLINE/WATER			
	300 G.P.M. @ 125 PRESSURE 4" INLET			
	& OUTLET COMP. W/VALVES & STRAINER	"	45-6780-[illegible]	[illegible]
2-40	SEPARATOR: GASOLINE/WATER			
	300 G.P.M. ASSEM.	"	[illegible]-0767.000-010	[illegible]
2-41	TANK: GAS. BL'TD. STEEL 1000 BBL. [illegible]	"	[illegible].710-010	[illegible]
2-42	TEE: M.I. VICTAULIC 6" x 6" x 6"	"	[illegible]-8684.[illegible]-046	[illegible]
2-43	REDUCER: VICT. TYPE STD. WT. G.B.E. 6" x 4"	"	45-6638.060-[illegible]	[illegible]
2-44	UNION: G.J.M.I. SCR. STD. 3/4"	"	45-8892.[illegible]	[illegible]
2-45	VALVE: GATE, SCR. 125# ST. 200# OWG - ¾"	"	45-8840.300-[illegible]	[illegible]
2-46	VALVE: RELIEF, GASOLINE SCR. SET @			
	200# ¾" FEMALE INLET & ¾" FEMALE			
	SIDE OUTLET.	"	45-8813.075-[illegible]	[illegible]
2-47	VALVE: ANGLE, SCR. 125# ST. OIL OR GAS 1½"	"		[illegible]
2-48	VALVE: CHECK SWING FLANGED 125# ST.			
	200# O.W.G. 4"	"	45-8838.[illegible]	[illegible]
2-49	VALVE: GATE FLANGED 125# ST. 200# OWG 4"	"	45-8840.[illegible]	[illegible]
2-50	VALVE: " " " " " " 6"	"	45-8840.[illegible]	[illegible]
2-2	ADPT. FAB. 4" STD. PIPE 8" LG. O.E.G. SERIES 15 FLG.	"	45-1122.[illegible]	[illegible]
2-4	BOLT: MACH. SQ. HD. W/HEX. NUTS [illegible] x 3"	"	[illegible]	[illegible]
2-9	COUP: VICT TYPE, W/BOLTS, NUTS & GASKETS [illegible]	"	[illegible]	[illegible]
2-10	" " " " " " 6"	"	45-2900.300-[illegible]	[illegible]
2-51	ELBOW VICTAULIC 45° - 4"	"	45-4002.[illegible]	[illegible]
2-22	GASKET: ASBESTOS RING [illegible]	"	33-3074.[illegible]	[illegible]
2-52	PIPE: STEEL, LIGHT WEIGHT G.B.E. 4"	"	44-6276.040-[illegible]	[illegible]
2-43	REDUCER: VICT. TYPE STD. WT. [illegible]	"	45-6638.060-[illegible]	[illegible]
2-42	TEE: M.I. VICTAULIC 6" x 6" x 6"	"	45-8684.[illegible]	[illegible]
2-49	VALVE: GATE, FLGD. 125# ST. 200# OWG 4"	"	45-8840.[illegible]	[illegible]
2-53	SEPARATOR — WATER/GASOLINE			
	200 G.P.M. @ [illegible] PRESSURE 4" INLET &			
	OUTLET W/CONDENSATE [illegible], AUTOMATIC		45-6760.[illegible]	[illegible]
	PLUG VALVE & STRAINERS.			

EACH-REFERS TO 20' LENGTHS

REFERENCE DRAWINGS

Y&D 398900 TO 913 INCL.

APPROVED BY BUREAU OF

FUNCTIONAL COMPONENT

5		
4		
3		
2		
1	[illegible]	CHANGED ITEMS 2-10, 32, [illegible]
Revision	Date	Brief

ARMY	NAVY
STOCK NO.	ASSEMBLY NO.
00-0890.000-010	2212
00-0767.000-010	2213
00-0955.000-010	2214

Prepared by C.M.B. [illegible]
Traced by W.L.B.
Checked by [illegible]
Supervisor [illegible]
Group Chief [illegible]
Chief Draw. [illegible]
Proj. Mgr. [illegible]
Design Mgr. [illegible]

NAVY DEPARTMENT — BUREAU OF YARDS & DOCKS

ADVANCED BASES

ARMY-NAVY FUEL FACILITIES

READY STORAGE GASOLINE RACK & WATER SEPARATOR

Approved Aug. [illegible] 194[illegible]

Scale AS NOTED

W.F. NUMBER [illegible]

Y. & D. Drawing No. 398911

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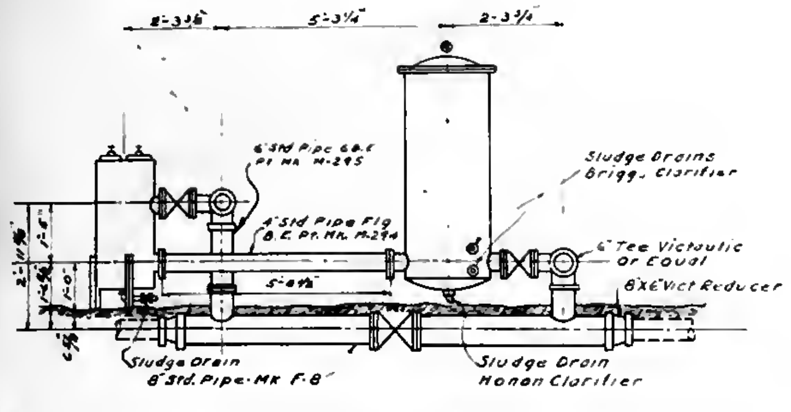
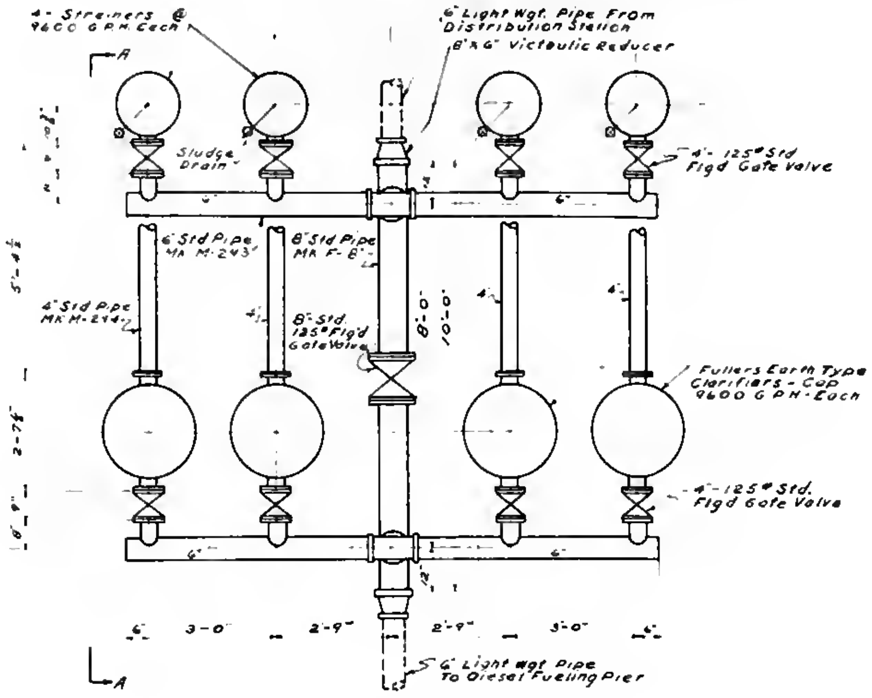
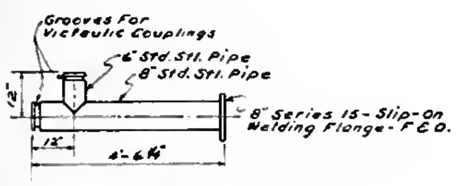


SECTION "AA"
SCALE ½"=1'-0"

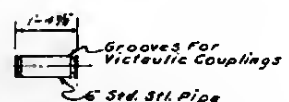


PLAN OF DIESEL CLARIFIER STATION
Scale: ¼"=1'-0"

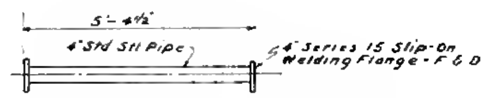
ASSEMBLY-2215



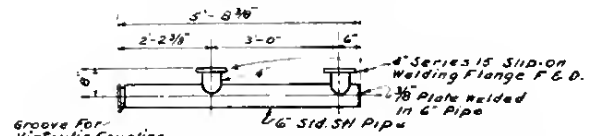
PART MK. F-8 (2H74-5)
Scale: ½"=1'-0"



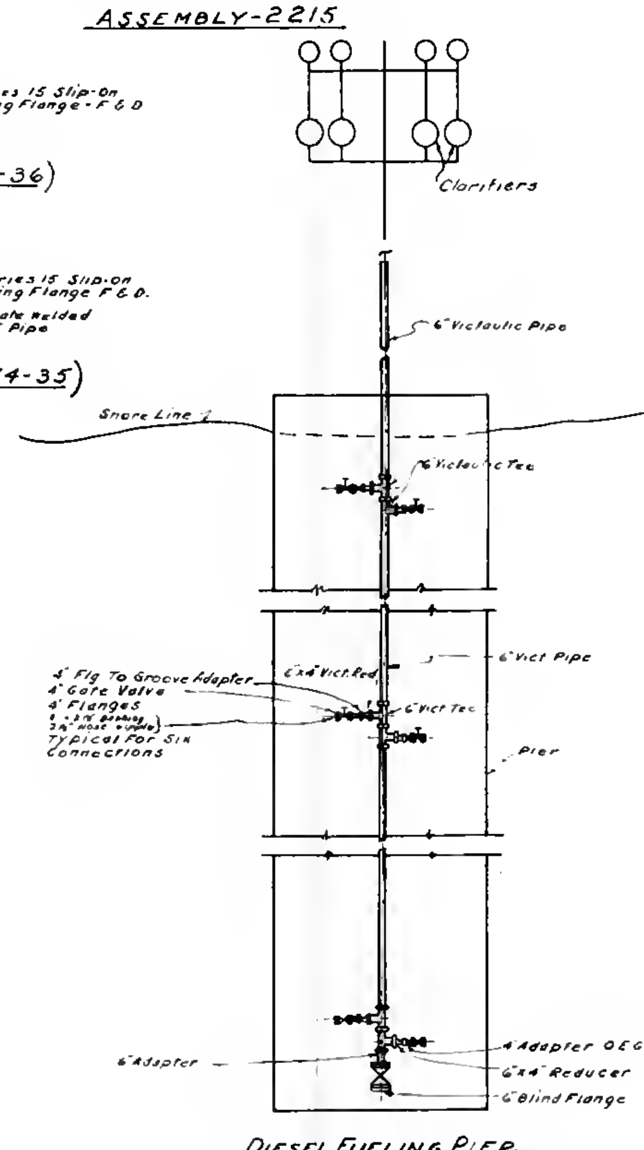
PART MK. M-295 (2H72-462)
Scale ½"=1'-0"



PART MK. M-294 (2H74-36)
Scale: ½"=1'-0"



PART MK. M-293 (2H74-35)
Scale: ½"=1'-0"



DIESEL FUELING PIER
SCALE ¼"=1'-0"

ASSEMBLY-2216

BILL OF MATERIAL

ITEM NO	DESCRIPTION	UNIT	STOCK NO ARMY	STOCK NO NAVY	QUAN.
	CLARIFIER DIESEL OIL W/STRAINER			2215	
2-1	BOLT: MACHINE, SQ. HD W/HEX NUTS, 5/8 X 3"	EA	[illegible]	[illegible]	220
2-2	" " " " " " 3/4 X 3½	"	[illegible]	[illegible]	20
2-3	CLARIFIER, DIESEL OIL, FULLER'S EARTH				
	TYPE, 4" FLANGED INLET & OUTLET 9600 GPH.	EA.		2H112-1	4
2-4	COUPLING: VICTAULIC TYPE W/BOLTS				
	NUTS & GASKETS 6"	EA.	[illegible]	[illegible]	10
2-5	COUPLING: VICTAULIC TYPE W/BOLTS				
	NUTS & GASKETS 8"	EA.	[illegible]	[illegible]	3
2-6	GASKET: ASBESTOS RING 1/16" THICK 4"X6 7/8"	"	[illegible]	2H67-9	30
2-7	" " " " " 6"X 11"	"	[illegible]	[illegible]	3
2-8	PIPE: STEEL STD. FABRICATED 8"X8"X6"				
	4'-6¾" LG (MARK F-8)	EA		2H74-5	2
2-9	PIPE: HEADER OEG, OE SEALED 6"X5'-8⅜"	"		2H74-35	4
2-10	PIPE: F&E W/SERIES 15 SLIP ON WELDING				
	FLANGES, 4"X5'-4½"	EA.		2H74-36	4
2-11	PIPE. G.B.E. 6"X1'-4⅛" LG	"		[illegible]	1
2-12	REDUCER: VICTAULIC TYPE, STD. GT. 8"X6"	"	[illegible]	[illegible]	2
2-13	STRAINER: DIESEL OIL, SCRAPER TYPE, 4"				
	FLANGED INLET & OUTLET, 9600 GPM.	EA.		[illegible]	4
2-14	TEE: VICTAULIC 6"X6"X6"	"	[illegible]	[illegible]	2
2-15	VALVE: GATE FLANGED 125# ST 200# OWG 4"	"	[illegible]	[illegible]	8
2-16	" " " " " " " 8"	"	[illegible]	[illegible]	1
	DIESEL OIL PIER W/FUELING ACCESSORIES			2216	
2-1	ADAPTER: FABRICATED 6" STD PIPE 6" LONG.				
	OEG, OE SERIES 15 SLIP ON WELDING FLANGE.	EA.	[illegible]	[illegible]	1
2-2	ADAPTER: FABRICATED 4" STD. PIPE 6" LONG.			—	
	OEG, OE SERIES 15 SLIP ON WELDING FLANGE.	"	[illegible]	[illegible]	6
2-3	BOLTS: MACHINE, SQ. HD. W/HEX NUTS ⅝"X3"	"	[illegible]	[illegible]	180
2-4	" " " " " " ¾"X3½"	"	[illegible]	[illegible]	20
2-5	CLARIFIER: DIESEL OIL W/STRAINERS.	"		2215	1
2-6	COUPLING: VICTAULIC TYPE WITH BOLTS,				
	NUTS & GASKETS. 6"	"	[illegible]	[illegible]	55 *
2-7	COUPLING: VICTAULIC TYPE WITH BOLTS				
	NUTS & GASKETS. 4"	"	[illegible]	[illegible]	6
2-8	FLANGE: BLIND C.I., F&D, 125#-6"	"	[illegible]	[illegible]	1
2-9	" C.I., SCREWED, F&D, 125#-4"	"	[illegible]	[illegible]	6
2-10	GASKET: ASBESTOS RING 1/16" THICK 4"X6 7/8"	"	[illegible]	2H67-9	20
2-11	" " " " " 6"X8¾"	"	[illegible]	[illegible]	5
2-12	HOSE: CARGO, MALE & SWIVEL FEMALE NSHT				
	COUPLING 4"X25' LONG.	"		[illegible]	10
2-13	HOSE: CARGO & SUBMARINE, SERIES 15				
	FLANGED ENDS 6"X25' LONG.	"	[illegible]	[illegible]	6
2-14	HOSE: GASOLINE, MALE & SWIVEL FEMALE				
	NSHT COUPLINGS 2½"X25' LONG.	"		2H111-32	10
2-15	PIPE: STEEL, LIGHT WEIGHT, GBE 6"	"	[illegible]	2H72-3	25 *
2-16	REDUCER: VICTAULIC TYPE STD. GROOVE 6"X4"	EA.	[illegible]	[illegible]	6
2-17	TEE: VICTAULIC 6"X6"X6"	"	[illegible]	[illegible]	6
2-18	VALVE: GATE FLANGED 125# STEAM 200# OWG 4"	"	[illegible]	[illegible]	6
2-19	" " " " " " " 6"	"	[illegible]	[illegible]	1
2-20	BUSHING: IRON STD. 4"X2½"	"	[illegible]	[illegible]	6
2-21	NIPPLE: HOSE, MALE & FEMALE, 2½" MALE-IPTR	"			
	2½" FEMALE NSHT.	"		[illegible]	6

EACH-REFERS TO 20' LENGTHS

NOTES

REFERENCE DRAWINGS

Y&D" 398,900 TO 913 INCL

FUNCTIONAL COMPONENT

Revision	Date	Brief	By
1	4-11-51	CHANGED ITEMS 2-6 & 15 (ASSY 2216)	[illegible]

*

STOCK NUMBERS	
Y&D	SNS
2H80-44	Y45-C-5068-125
2H72-3	Y44-P-1315-660

Prepared by C.L.M.
Traced by A.E.L.
Checked by G.M.R. :CH
Supervisor C.J.M.
Group Chief
Chief Dftsm. CHD
Des. Engr.
Proj. Mgr.
Design Mgr.
Sheet of
ASSEMBLY NO 2215 2216
Scale: AS INDICATED
N.K NUMBER 045-884

NAVY DEPARTMENT BUREAU OF YARDS & DOCKS

ADVANCED BASES
ARMY-NAVY FUEL FACILITIES
DIESEL OIL PIER
CLARIFIERS & ACCESSORIES

Approved Aug. 30, 1945
For Chief of Bureau
Y. & D. Drawing No. 398,912

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APPENDIX, Figure 9

250837

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3. NAVSANDA Publication No. 18, *Fuel Depot Handbook*, Washington, D. C., U. S. Navy Department (1944).

4. MIL-F-7914 (AER), *Military Specification, Fuel, Aircraft Turbine and Jet Engine, Grade JP-5*, Washington, D. C., U. S. Navy Department (1952).

5. NAVDOCKS p-112, *Advanced Base Fuel Storage*, Washington, D. C., U. S. Navy Department (1949).

6. *World Oil*, 136, p. 311 (April, 1953).

7. "Breather Balloon Reduces Vapor Losses," *Petroleum Engineer*, 21, pp. 39-40 (November, 1949).

8. Wilson, Gilbert M., "Lightweight Plastic Pipe is Meeting Specialized Needs," *World Oil*, 153, pp. 270-275 (November, 1952).

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4. MIL-F-5624A (ASG), *Military Specification, Fuel, Aircraft Turbine and Jet Engine, Grade JP-3*, Washington, D. C., U. S. Navy Department (1952).

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6. *World Oil*, 136, p. 311 (April, 1953).

7. "Breather Balloon Reduces Vapor Losses," *Petroleum Engineer*, 21, pp. 39-40 (November, 1949).

8. Wilson, Gilbert H., "Lightweight Plastic Pipe in Meeting Specialized Needs," *World Oil*, 153, pp. 270-275 (November, 1952).